WORLD NAVIES

By Oscar Parkes

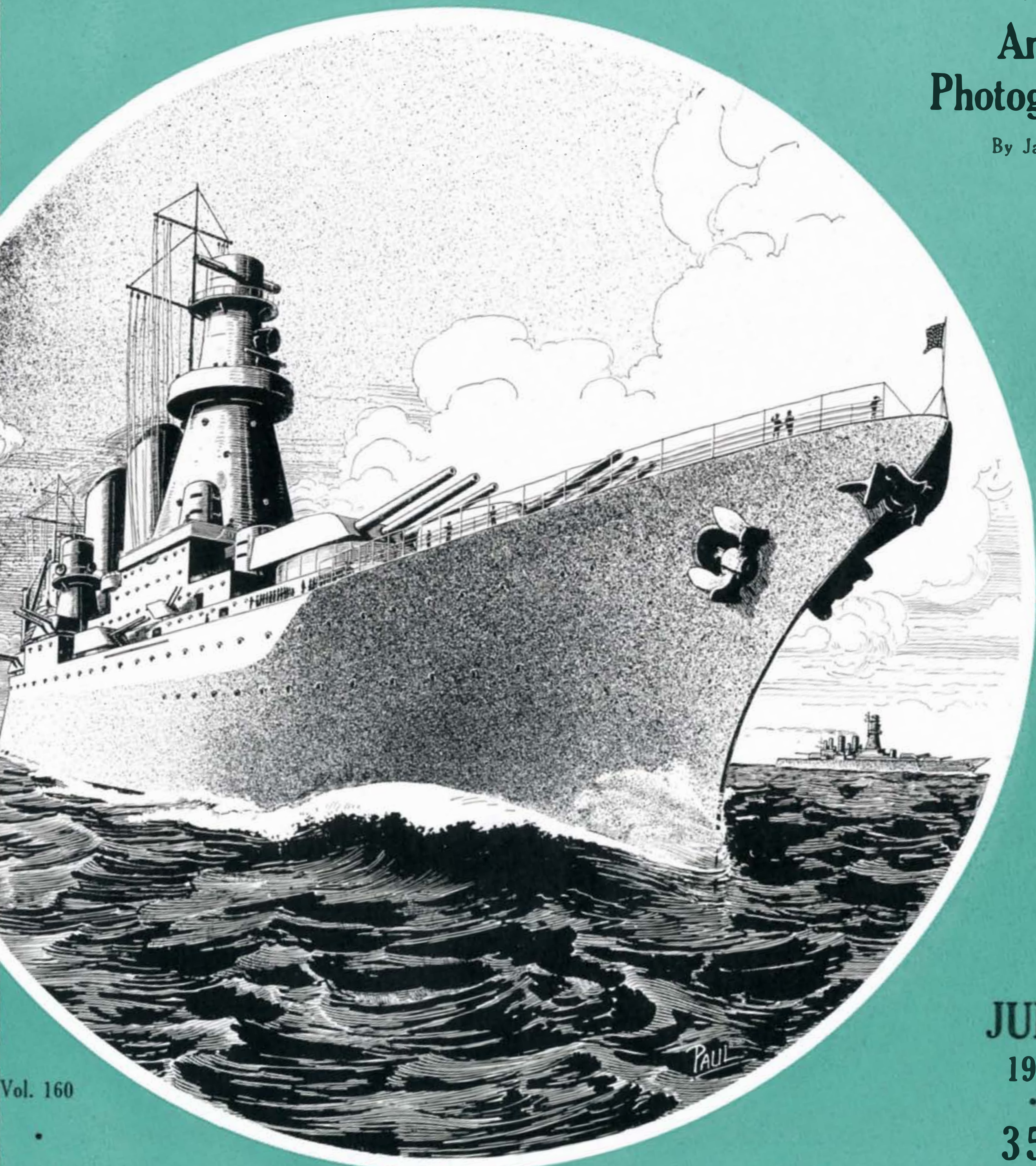
SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur
Photography

By Jacob Deschin



Vol. 160
•
No. 6

JUNE
1939
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SCIENTIFIC AMERICAN

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NINETY-FIFTH YEAR • ORSON D. MUNN, Editor

CONTENTS • JUNE • 1939

OUR cover this month is an artist's conception of the new *North Carolina* class of battleships being built for the United States Navy. From the unusual angle almost beneath the graceful clipper bow, our artist has captured a feeling of power and speed as well as shown a number of the important features of these ships discussed by Oscar Parkes in the article beginning on page 351. See also Dr. Parkes' drawing of the *North Carolina* on that page.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, June, 1939. Vol. No. 160, No. 6, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

Books

SELECTED BY THE EDITORS

NATURE PHOTOGRAPHY AROUND THE YEAR

By Percy A. Morris

AMATEUR photographers who are looking for something new and different to do with their cameras will find here a vast and fascinating field for conquest. Considerable attention is given to the equipment both necessary and desirable for nature photography, whereupon the text plunges directly into a series of 12 chapters, each devoted to the type of nature photography that can be done during 12 months of the year. It is one thing to attempt to take photographs of natural history subjects; it is quite another thing to produce satisfactory pictures. The author draws upon his experience to show the reader just how to go about producing the best possible results under adverse conditions. Birds and bird nests, insects and small animals, flowers and trees, are a few of the photographic subjects discussed. (251 pages, 6 by 9 inches, thoroughly illustrated with photographs and drawings.)—$4.20 postpaid.—*A. P. P.*

THE CHEMICAL FORMULARY, VOLUME IV

Edited by H. Bennett

THOUSANDS of new formulas are presented in this fourth volume, which is separate and distinct from the three preceding ones. Particularly useful to laboratory and industrial chemists, these formulas are also valuable to the layman experimenter who desires to make products used every day in the home. Comprehensive index. (638 pages, 6 by 9.)—$6.10 postpaid.—*F. D. M.*

PLANT GROWTH-SUBSTANCES

By Hugh Nicol

CHEMISTS have discovered in recent years substances which the gardener, the horticulturalist, botanist, and others may use to hasten the rooting of cuttings or change completely the rate of plant growth. These are discussed in great detail in this volume which, generally speaking, is for the layman but is rather technical in spots. For the advanced student or grower, this book takes up where others on chemical gardening leave off. (106 pages, 5¼ by 8, illustrated, several bibliographies.)—$2.10 postpaid.—*F. D. M.*

INDUSTRIAL CHEMISTRY

By E. R. Riegel

THAT a second printing of the third edition of this valuable treatise on industrial chemistry has been needed, is evidence of value. As a work for ready reference on industrial chemical practice it is among the leaders in the English language. (851 pages, illustrated.)—$5.85 postpaid.—*D. H. K.*

SCIENCE AND PSYCHICAL PHENOMENA

By G. N. M. Tyrrell

COMPACTLY, systematically, the author surveys the whole field of psychical research in a way that none has done before. His findings are guardedly favorable to a large part of the content of psychical phenomena (excluding much that seems like sheer trickery) but he presents them in such a calm, dispassionate manner that they will carry more weight than some, if not the major part, of the pleadings of others for the validity of these things. It is as though someone were lecturing in a quiet, low voice instead of the too-usual warm, eloquent manner of the eager-to-believe school. (379 pages, 5¼ by 8½ inches, unillustrated).—$3.85, postpaid.—*A. G. I.*

TROUT STREAMS

By Paul R. Needham

STREAM management and trout culture are the two general subjects that are treated in this important contribution to the literature of fish conservation. Every sportsman who is interested in keeping our inland waters clean and productive will want to have a copy of this book. (232 pages, 6½ by 9½ inches, drawings and photographs.)—$3.20 postpaid.—*A. P. P.*

THE EIGHTH ART

A Life of Color Photography

By Victor Keppler

COLOR photography is here to stay for both professionals and advanced amateurs. In the present book the author has gathered a tremendous amount of material and has presented it in an unusual and interesting form. First is given a history of color photography and of the various processes which have been used and which are in use today. The text then deals with the preparation of separation negatives, carbro printing, color portraiture by various methods, and, in more or less detail, with all of the color processes available today. The advanced amateur is by no means forgotten; a separate chapter is devoted to the technique which he should use to obtain the best results. (266 pages, 9½ by 12½ inches, 31 color plates, many of them full page.)—$10.25 postpaid.—*A. P. P.*

QUARTZ FAMILY MINERALS

By H. C. Dake, Frank L. Fleener and Ben Hur Wilson

A PRACTICAL handbook for the mineral collector, with chapters on how to know quartz, its historical lore, how it crystallizes, its crystalline, massive and intermediate as well as amorphous forms, agate, chalcedony, geodes, unusual quartz types, opals, petrified wood. There is also a chapter on the art of cutting quartz gems. (304 pages, 5½ by 8 inches, many illustrations.)—$2.60, postpaid.—*A. G. I.*

We can supply our readers with any of the books reviewed in this department. Prices quoted include domestic postage. Foreign prices are necessarily higher due to increased shipping charges.

SCIENTIFIC AMERICAN
24 West 40th Street New York, N. Y.

FOR OTHER BOOKS YOU WANT, SEE PAGE 388

OUR POINT OF VIEW

Destructive Taxation

THE publishers of Scientific American have rarely presented in its columns discussions of either political or legislative nature. In view, however, of the confiscatory terms of Senate Bill (S 1885) known as the War Profits-Tax Bill, and the fact that most of the daily press has discussed the Bill only in a brief manner, we feel impelled to present to our readers some of the specific terms of the Bill, which if enacted into law, would, in time of war, stagnate industry and pauperize the tax-payer. We do not recall any proposed legislation emanating from our elected representatives which could be more harmful to the well-being of our country than the Bill under consideration, and it is hard to conceive why such a pernicious measure should receive serious consideration by our legislators.

Bill S 1885 would apply the following scale of income taxes to the individual: the normal tax would be increased from 4 percent to 6 percent and a surtax rate of 10 percent would be imposed on incomes between $3000 and $5000. The next $1500 of net income would carry a surtax of 30 percent; the following $1500 of income would be taxed at the rate of 50 percent; the surtax rate on the next $12,000 would be 70 percent; and all net income in excess of $20,000 would be taxed at the rate of 93 percent.

If this Bill should be passed, corporations will be strangled by the imposition of a tax which is intended to limit their profits in time of war. Computation of the tax will be based on the declared capital stock values as of the year *1934* as adjusted to the end of the calendar year preceding a war declaration. Income up to 2 percent of adjusted declared value will be taxed at the rate of 15 percent; over 2 percent and not over 6 percent of adjusted declared value will carry a tax of 25 percent; all corporate income in excess of 6 percent adjusted declared value will be taxed at the rate of 100 percent.

Space does not permit a full discussion of those features of the proposed Act which include a burdensome tax on undistributed profits, the filing of quarterly returns by corporations, and the length of time for which the tax becomes effective. Neither can we go into detail regarding the personal exemptions which would be so drastically reduced as to approach the vanishing point.

It is said that 50 Senators have approved the War Profits-Tax Bill, and while that fact does not assure its passage, the tax-payer should take every precaution against the possibility of the Bill's approval by procuring a copy of it and filing strong protest with his Senators and Congressmen.—*O. D. M.*

Fewer Farmers

SOME people did not even know that this country has changed from a nation of farmers into one composed largely of city workers. Those who did know this fact knew it in a general sort of way only and probably never did imagine the proportion to be: one fifth in agriculture and four fifths in city work. Few ever gave much thought to the metamorphosis or the reasons for it.

Sensational headlines are, therefore, indicated. Yet the Department of Agriculture recently announced quite casually in one of its press notices: "Why City Workers Outnumber Farmers." Not that we go in for glaring headlines or melodramatic eye-catchers. We don't. But here is a subject to be picked up by the daily press and given life and color befitting its importance in the American scheme of things. For, linked inseparably to it, causing it, and benefitting by it are American democracy and the genius that made us great, Yankee ingenuity and the pioneer spirit, and the profit motive in free enterprise.

Reapers, gins, combines, corn harvesters, tractors, and hundreds of other labor-saving devices have given greater farm production with fewer farm laborers. At the same time the expansion of industry has provided more jobs in and around cities. Improvements in distribution and processing have done their bit by assuring the farmer that a larger percentage of his produce would reach the market unspoiled or would reach a more favorable, distant market, and then, perhaps, be processed into new forms.

Technology and invention made possible or caused—depending on one's way of looking at it—this change in a nation's working habits. That, too, may sound matter-of-fact; yet it takes not even an intelligent imagination but only a knowledge of the facts of history to see bound up within it romance and heart-break, achievement and hardships. Farmers, themselves, provided many of the developments that have improved our farming methods. Others who were primarily inventors supplied many inventions. But research workers, industrialists, men with vision to see possibilities and courage to carry through have done a larger job in developing correlative services, industries, processes, and markets. Struggle has been the keynote of the efforts of all these, and some have, indeed, suffered discouragement and poverty. Yet out of their work has come, not simply fewer farmers and more city workers, but an enormously improved standard of living. —*F. D. M.*

Toward Conservation of Wasted Power

JUST as the Emily Posts of good etiquette and best breeding have practically completed the diplomatic isolation and military encirclement of that ill-mannered, all-American habit of chewing gum with the mouth wide open, the science of psychology has extended to gum chewing full diplomatic recognition and an alliance. In a paper learnedly entitled "The Psycho-dynamics of Chewing," Professor Harry L. Hollingworth, Columbia University psychologist, has announced the results of four full years of research on numerous chewing and non-chewing subjects, to prove to us what we already knew—that gum chewing raises the energy quotient of the chewer. He found that writers, for example, pressed harder on their pencils, while typists typed faster. Nervous tension decreased and habits such as foot tapping drained off through the gum.

Without Emily Post's permission we have been peeking into Department of Commerce statistics on chewing gum, and we find that the industry has 26 establishments employing some 2300 workers, uses about $15,000,000 worth of materials—chicle, crude gum, sugar, corn syrup, flavoring—in making a product having an annual value of about $50,000,000. Some $75,000 worth of electrical energy is consumed and this represents the first or primary gum industry; what of the second?

The $50,000,000 annual product value, divided by five cents, the price of a packet of gum, represents roughly a billion purchases containing about ten billion chews. Allowing three hours per chew, and assuming the brake horsepower of the prime mover at, say, one thirtieth (although some we see look more like a full horsepower and often sound like ten), we arrive at something like one billion horsepower-hours of power generated the nation over, each year. The primary gum industry isn't a patch on this, the secondary one!

Who now will find a way to collect the wasted gum-power, return it to the gum manufacturers to be used in making more gum to release more gum-power, and so on and on—a regenerative feedback, almost perpetual motion!—*A. G. I.*

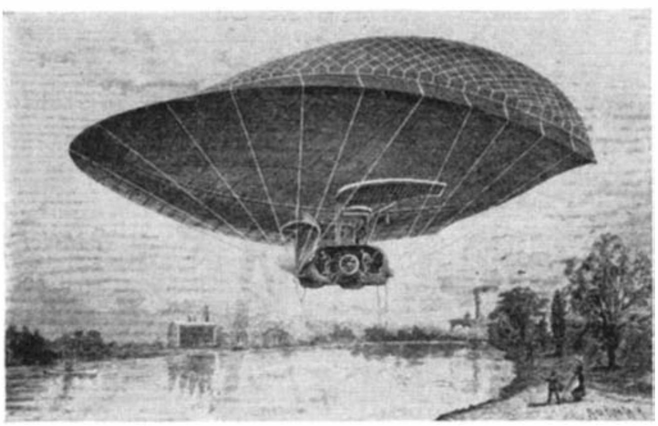
50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of June, 1889)

PIGS IN CLOVER—"The value of little inventions has had a singular proof or manifestation lately in the great run on 'Pigs in Clover,' a puzzle that has, we venture to say, been seen by nearly all our readers, for it has already made its way everywhere. . . . Three hundred gross have been turned out daily for some time, while the demand has not yet been met by the supply."

AIRSHIP—"An airship designed to be completely under the control of the operator, and to be easily steered and propelled in any direction, with, on, or against the wind, is shown in the accompanying illustration. . . . The most prominent feature of the construction is a balloon made in three compartments, the lower one stiffened by a



framework and supporting the second compartment, on which is secured the third compartment, exposed to the action of the wind, and with its edges attached to the framework. A closed basket, the interior of which is partly shown, is supported on the under side of the balloon, and contains a motive power, preferably in bicycle form, for operating sidewise flapping wings and central wings."

TIES—"Assuming the entire railroad system of the United States to be 160,000 miles, as appears from 'Poor's Manual,' with the addition of the lines in construction during the current year, and taking 2640 ties per mile of track, we have in use at least 422,400,000 ties. This estimate, large though the total appears, is under the mark, as no railroad uses less than 2640 ties per mile, and many of the roads with heavy traffic have 2816, and in a few cases more."

HOBBIES—"Said a gentleman who had seen much of human life and was himself an enthusiastic student at threescore years: 'No man in this world can be happy without a hobby. . . . Indeed, for diverting our minds from the little crosses which we all have to bear, there is no earthly solace so healing as a subject in which we are intensely interested—something to which the thoughts may at any moment recur when weary of the suggestions we would escape. When, in addition to being an innocent diversion, ours is a useful study, we and our fellow-mortals are alike gainers. The person who passes through life without being an enthusiastic student of something loses more than he can appreciate.' "

NEW METALS—"At the last sitting of the Russian Mineralogical Society, K. D. Chrustschoff demonstrated the existence of a new metal which he has just discovered, and to which he gives the name russium. It approximates closely to thorium, and is one of the bodies whose existence was foreseen by Professor Mendelejeff. We learn also that Dr. Kruss has named the metal which he has detected along with nickel and cobalt, gnomium."

FLUME—"It is claimed that the recently completed San Diego flume . . . is the most stupendous ever constructed in the world, being only a little short of thirty-six miles long. . . . In the course of the flume there are some 315 trestles, the longest of these being 1700 feet in length, eighty-five feet high, and containing one-quarter of a million feet of lumber. Another trestle is of the same height, and 1200 feet long, the main timbers used in both of these being ten by ten and eight by eight, put together on the ground and raised to their position by horse power."

FLOOD—"The appalling disaster of the bursting of the dam holding back the waters of South Fork Lake in Pennsylvania, by which Johnstown and the villages and country near it on the main line of the Pennsylvania railroad were swept into ruin, will rank among the great catastrophes of the world. The English-speaking race has never before been afflicted by a catastrophe of equal moment. The flood, with the added horrors of conflagration, was due to the sudden escape of the waters of one of the largest artificial lakes in America."

CRUISER—"The Italian cruiser *Piemonte* was described . . . at the meetings of the Institution of Naval Architects by her designer, Mr. P. Watts. . . . During a natural draught trial of four hours' duration, a mean speed of 20.4 knots was attained with about 7000 indicated horse power; and during a forced draught trial of one and one-half hours' duration, a measured mile speed of 22.3 knots was attained with a mean power of 12,700 horses, the maximum power which was maintained for a considerable time exceeding 13,000 horse power. The displacement of this vessel is only 2500 tons, yet she carries six 6-inch quick-firing guns, six 4¾-inch quick-firing guns, and a large number of smaller guns."

CATERPILLARS—"The caterpillars, which are making their tents earlier this year than usual, owing to the warm spring weather, should be looked after at once. The simplest and perhaps, on the whole, the best way of getting rid of them is to brush off the nests from the trees as fast as they appear, with a long-handled conical-shaped brush."

TRANS-CHANNEL—"The English are contemplating an idea to lay down a postal tube between Dover and Calais. The plan is to suspend two tubes of about a yard each in diameter by means of steel cables across the channel, forty yards above the level of the sea. The steel cables will be fixed to pillars at distances of about 800 yards, and in each tube a little railway will run with cars capable of carrying 450 pounds in weight. No parcel of greater weight than this will be taken, and the cost is estimated at the modest figure of 5,000,000 dollars."

AND NOW FOR THE FUTURE

¶The Real Truth About the Lie Detector—Its Practical Limitations and Possibilities, by Thomas Hayes Jaycox.

¶Out of the Test-Tube Comes a Synthetic Rubber of Great Promise—The Story of Koroseal.

¶An Outstanding Engineering Achievement—the Nieuwe Maas River Tunnel in Holland, by R. G. Skerrett.

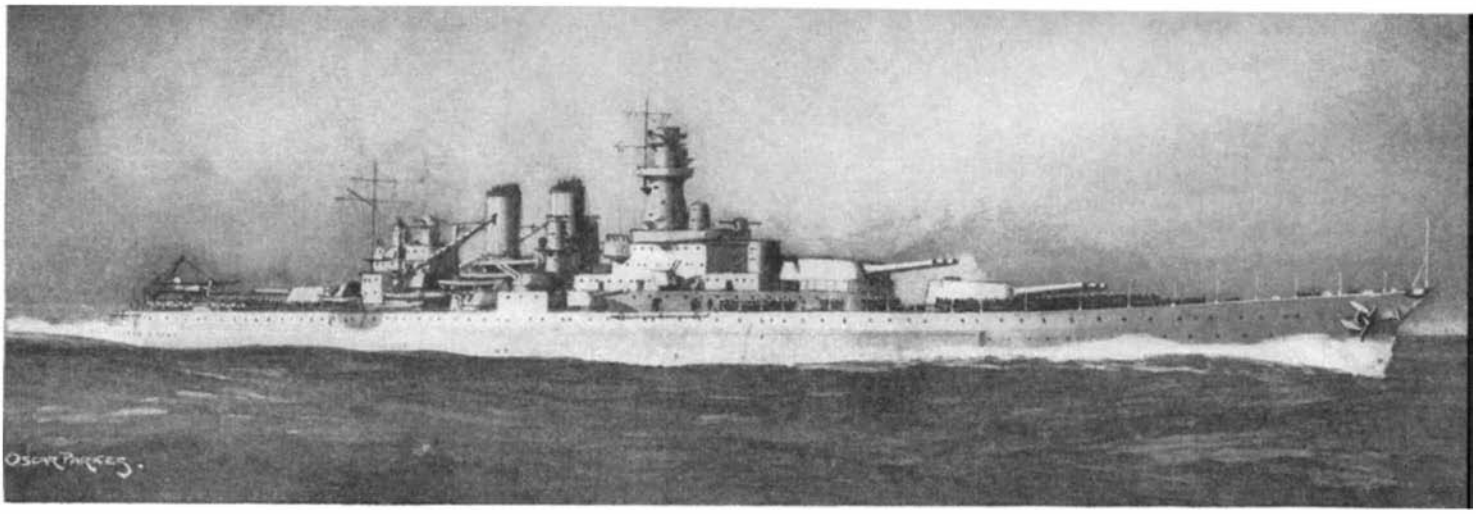
¶The Great American Rite—Tonsil Removal, So Often Unnecessarily, by T. Swann Harding.

¶Substitute Motor Fuels as Developed in Europe to Promote National Self-Sufficiency, by Gustav Egloff

Courtesy Westinghouse Elec. & Mfg. Co.

LOW COST CURE FOR RADIO INTERFERENCE

CONVENTIONAL high-voltage pin type insulators used by power companies and industrial plants generate radio interference at line and tie wires. This is due to minute arcs created at the point of contact between insulators and wires. In a new type of insulator, shown above being individually inspected in the production plant, a copper-oxide glaze is formed as an integral part of the insulator and is found to eliminate the minute arcing and hence radio interference. These insulators cost no more to produce than do the conventional trouble-causing type.



The "North Carolina," most powerfully armed of all capital ships now building—a fresh note in American ship silhouette

The Future of Navies

THOSE who have previously read Dr. Parkes' naval discussions in our pages and studied his telling wash drawings, will welcome this analysis of naval design and construction programs of World Powers. In the present article, he discusses the renascence of the battleship as a vital part of the fleets of the world, and in the concluding part, next month, takes up other categories.

For many years Editor of the justly famous "Jane's Fighting Ships" annual, Dr. Parkes is respected as an authority by naval men the world over. His entré to navy departments is such, therefore, as to enable him to obtain much information unavailable to other laymen. It follows that his opinions bear considerable weight.

We consider ourselves fortunate, indeed, in being able to present his two-part article to our readers. It is one of the finest in a sequence starting, Dr. Parkes reminds us, with our publication 26 years ago of his article on and drawings of the Japanese *Kawachi* and *Kongo*.—*The Editor.*

Powers Build Larger Battleships . . . Sizes, Armament, Armor . . . Use . . . Effectiveness . . . Concluding Discussion, on Other Ship Categories, Next Month

By OSCAR PARKES
Associate of Institute of Naval Architects

NOW that the Naval Treaty with its restrictions upon numbers, types, displacements, and gun calibers has been terminated, the naval Powers are free to design and arm their ships without let or hindrance, subject only to certain upper limits in battleship tonnage and gun-caliber which have been agreed upon by the European countries; and in a world antagonized, the armament race is being pursued with the grim intensity of pre-war days although with a dread foreboding in place of national pride in pomp and circumstance.

Already the alignment of forces is becoming obvious. Germany, having kicked over the Versailles traces, is bent upon the formation of a pan-German league which shall dominate Europe, and the recovery of her former overseas possessions for the purpose of creating the necessary supply bases from which commerce can be attacked. Italy visualizes a second Roman Empire with domination in the Mediterranean. Japan aims at the complete subjugation of China and acquisition of such additional territory now held by European nations as shall make her position secure. And behind it all is the necessity for foreign trade—trade assured by the national possession of great markets which may be closed to competitors—and sources of natural wealth from which the basic necessities of industry may be obtained without currency difficulties.

NATURALLY both Britain and France would be content with the *status quo*, but as the ambitions of Germany and Italy can only be realized at the expense of these two democracies, they have been compelled to "look to their moats." America sees the probable loss of her trade in the Far East—the future greatest market in the world—with the possibilities of pro-German trouble in South America and must needs remember that she may become involved in defending her interests in both the Atlantic and the Pacific. And so while Japan, Germany, and Italy can plan their forces with the object of attack, Britain and France must visualize the far more difficult problem of world-wide defense. America, having neither overseas possessions to tempt the "Have-nots" nor the problem of guarding an ocean-borne food supply, is in the happier position of being able to concentrate her energies upon what is recognized as the best form of defense.

Having thus outlined the ambitions—active or passive—of the Powers, we are in a position to appreciate the composition of the naval forces being amassed by each, and such peculiarity of type or design in the various classes of fighting ships as has been dictated by particular national requirements.

At the present time, history is going through a phase of repetition. Fifty years ago the battleship was popularly supposed to have become obsolete owing to the growth and alleged effectiveness of torpedo craft, and her place was to be taken by fast "protected" cruisers. The later development of quick-firing guns enabled the big ship to assume her rightful place as the prime unit of naval defense. Then, for some years after the World War, her pride was again humbled, this time by the submarine and airplane which, in combination, should theoretically have been able to drive the goliaths of the sea into impotent seclusion; but the inevitable development of defensive measures again assured their supremacy afloat, although to a more qualified extent.

Today, the measure of a battleship's powers of defense against air and underseas attack depends largely upon her displacement. Given sufficient beam, a ship can have enough bulges and internal longitudinal bulkheads to withstand several torpedo hits; given the weight of deck armor, she can be made to withstand heavy bomb attack. No ship can be made impregnable, but "the bigger the safer" is a sound axiom; and if very big guns are to be carried as well as an adequate secondary armament, certainly more than 35,000 or 40,000 tons will be necessary—at least 50,000 tons is regarded as the constructor's datum line. With such a displacement, the battleship will become a fantastically expensive weapon, with limits to numbers and an undue national value attached to each—loss of one meaning a catastrophe impossible to overcome during war.

Can the monster battleship be replaced by other types of warships—or by aircraft? So far as the British Admiralty is concerned, the answer is in the negative. In collaboration with the Air Ministry, the whole question of relative cost and upkeep with a given financial outlay has been thoroughly investigated and they have agreed that the present cost of a battleship can be represented by 43 twin-engined medium bombers, taking into consideration the overhead, maintenance, replacement, and similar charges to make an effective comparison during the life of a capital ship.

Actually, the relative costs of battleships and airplanes have not, in themselves, any bearing upon the matter. If capital ships are essential to security, they must be provided; the advocates of air power would wish that their country should build no more—although other Powers should still continue to build them. If their theories turn out to be well-founded, money has been wasted; if ill-founded, the test of them would result in the loss of perhaps an empire.

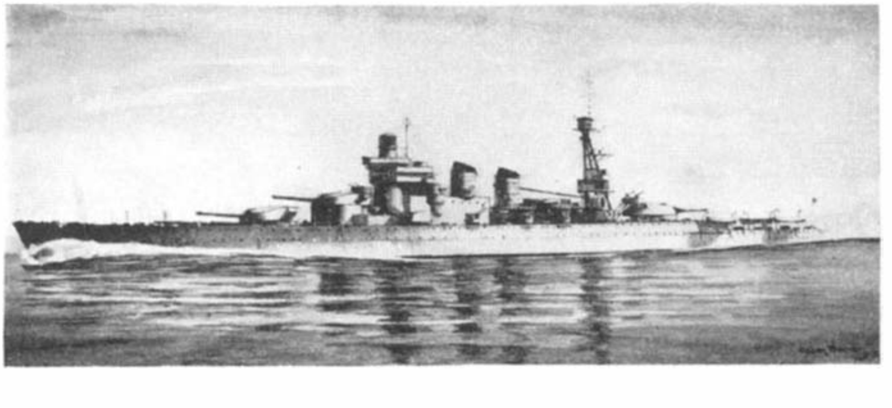
How, then, are battleships likely to be employed in future warfare? In the past they were used: (1) on blockade; (2) to cover landing operations; (3) for bombardment; and (4) to bring the enemy fleet into action. Today submarines and aircraft will put (1), (2), and (3) out of court; these duties will be relegated to lighter craft and the battlefleet will exercise its influence only as a distant covering force. But, whereas commerce raiding and convoy protection were formerly essentially cruiser duties, in future hostilities we must be prepared to see battleships let loose upon the trade routes, making the problem of commerce protection increasingly difficult and complicated. Naval warfare will turn more and more upon the attack and defense of merchant shipping, with every type of vessel being employed, the battlefleet playing an active or expectant part as the attacking forces utilize their capital ships as corsairs.

THE present growth in battleship tonnage, as shown in this present review of 35,000 tonners being built by the Powers, is due to Japan's having withdrawn from the Naval Conference two years ago. When she intimated her unwillingness to continue the exchange of naval information or to adhere to the limitations in displacement hitherto observed by the Powers, it was generally anticipated that her intention would be to enlarge her battlefleet by the construction of ships of more than 35,000 tons—which was the agreed limit—and with her predilection for the heaviest guns, everything pointed to an increase in their carrying weapons of more than 14-inch caliber. In due course, it was reported that three or four 40,000 tonners carrying 16-inch guns had been laid down, and as neither confirmation nor denial of this was vouchsafed by the Japanese authorities, there was no other course open for the United States and British Governments but to conclude that this information was probably correct and to increase the dimensions and armament of their new ships accordingly.

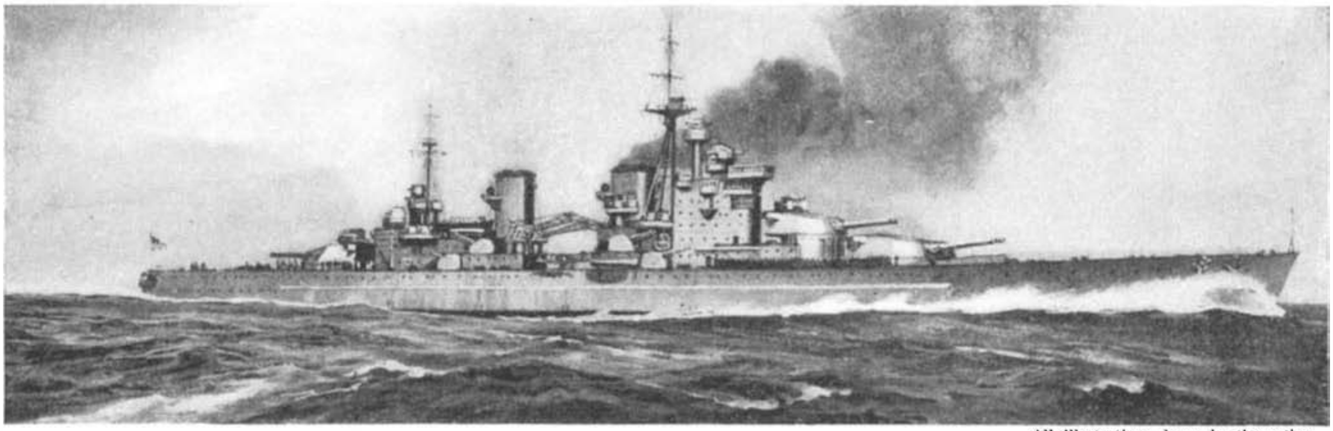
On the other hand, it must be remembered that the Treaty also provided that no warship other than a capital ship should carry a gun of greater caliber than 8 inches—which precluded the construction of a variety of intermediate types such as the German *Deutschland* and light battle-cruisers. This wise provision simplified design and eliminated the risk of existing types being compromised by hybrids. But today the sanctity of Treaty designs no longer obtains. Japan *may* have no intention of embarking upon a vastly expensive big-ship program. Her secrecy may be an excellent cover for what might prove a far more troublesome Treaty escape—the construction of "intermediate" ships. In the past, she has complicated the accepted categories by such ships as the 12-inch gun, armored cruisers *Tsukuba* and the larger *Kurama* of 1905; and after the War when introducing the 8-inch gun in the *Kako* class (1922) she initiated the Washington cruisers—which were neither wanted nor welcomed! Today, it is quite in the cards that the 40,000 tonners are a blind and that fast, 12-inch-gunned ships of moderate tonnage are being built. If so, our troubles in Eastern waters will be considerably increased as such ships would be able to smash up the standard 8-inch gun cruisers and escape from any of the 21-knot battleships which are at present available and which cannot be reinforced by faster capital ships for some years to come.

The American answer to the Japanese challenge is a class of six 35,000-ton ships of the *North Carolina* class now being built under the 1937-38 programs. They carry an armament of nine 16-inch and 20 5-inch guns, with two triple turrets forward and one aft, with the secondary guns—of which eight are reported to be 5-inch, 25-caliber anti-aircraft—grouped in small turrets amidships. To a large extent they represent the conventional layout observed by all the Powers except France. Formerly, it was customary to break the hull line by a deck at the after superstructure and space the secondary battery along the upper deck side or along the superstructure deck in casemates. Nowadays the demands for high-angle fire and wide arcs of training have led to the adoption of small turrets on two levels to avoid interference. In the *North Carolinas*, four of these are on the weather deck and six on the superstructure, with multiple anti-aircraft positions high up on the fore and aft shelter decks. At the stern are two catapults with a hull hangar as in the *Brooklyn* cruisers—an admirable arrangement if practice bears out theory.

In these days when so much information is confidential, only a general idea of armor thickness is available. This indicates that the waterline belt is of 16-inch armor amidships from the fore to the after turrets, with a six-inch upper deck and a four-inch lower deck—these being very heavy to withstand plunging fire from big guns and heavy bombs.



Italy's "Littorio" and "Vittorio Veneto," to be ready this summer—the first of the 35,000 tonners being built by the Powers. For a time they will be most formidable ships afloat



All illustrations drawn by the author

H.M.S. "King George V," of a class of five now building. Note secondary guns paired in shields athwart funnels

The designed speed is reported to be about 28 knots, in which case the class will be about two knots slower than the British, French, and German 35,000 tonners. However, as they carry 16-inch against 15-inch or 14-inch guns and are specifically designed to meet the Japanese battleships of alleged greater tonnage with 16-inch weapons, the sacrifice of speed is that which can best be afforded in a compromise of military and nautical qualities. Nowadays no figures of fuel capacity are officially supplied, but these ships should have a maximum of well over 4000 tons of oil.

As the cage mast gave way to the tripod, and that, in its turn, has been superseded by the bridge-and-tower structure of the *Idaho* class, so in the *North Carolina* a new type has been evolved: a truncated cone supporting the heavy range-finder which resembles the "mast" favored by the Germans. Aft, there is a light pole only—the remnant of a main mast which is now just a hindrance to sky-fire. A glance at the layout of previous battleships will show to what an extent their after tripods or cages mask the anti-aircraft guns on any off-side ceiling; and the present tendency is to afford as wide and as uninterrupted a field as possible to anti-aircraft defense.

In Britain, two classes of battleship are now in hand: the *King George V*; and the *Lion*. The former, designed in accordance with Treaty limits, is of 35,000 tons and armed with 14-inch guns. No dimensions have as yet been published, but the length is about 750 feet as in the United States' ships; and the main armament of ten guns is carried in three turrets: a quadruple and a twin superfiring forward and a quadruple aft. This is a complete breakaway from the *Nelson* layout with its three turrets up forward, and allows for a good all-'round concentration of fire. Instead of the customary 6-inch gun for secondary armament, a new gun of 5.2-inch has been adopted. Sixteen of these are carried in four groups of twin turrets, the inner guns being raised on small separate superstructures. Multiple pom-poms are mounted on the crowns of *B* and *C* turrets and on platforms abreast of the fore funnel, which allows for wide arcs of sky fire. Other anti-aircraft guns are disposed on the superstructures. On deck between the funnels is laid a thwartships-catapult with hangars for four aircraft on each side of the fore funnel, the cranes for handling both aircraft and boats being stepped on the after superstructure. Between the end turrets, there is a belt of 16-inch armor, tapering to 15-inch, reaching up to the main deck, and over 14,000 tons of armor have been distributed over the sides and decks. Unofficial reports credit a speed of 30 knots with 130,000 horsepower.

This class will be retained in European waters when they are commissioned in 1940 and 1941.

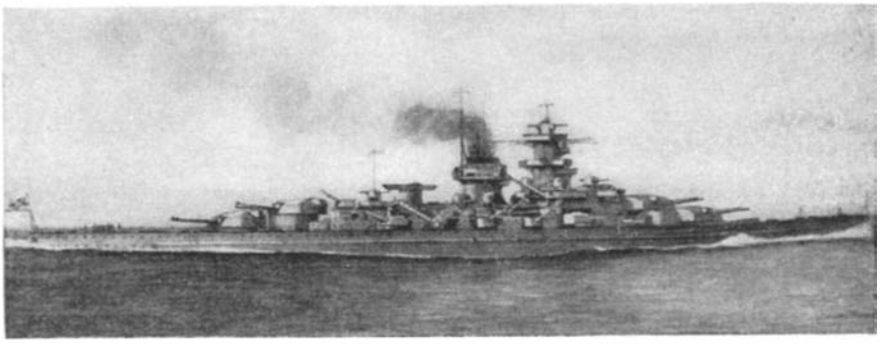
In their four vessels of the *Richelieu* class, the French have retained the characteristics of the previous *Dunkerque* (26,500 tons, eight 13-inch guns), enlarging the hull to the 35,000 ton limit in order to carry eight 15-inch guns. These are in two widely separated turrets forward, in each of which are two pairs of guns separated by an armor bulkhead —a disposition permitting a heavy concentration of fire forward and just abaft the beam but powerless to engage an enemy on the quarter or astern. Although this is admirable as an offensive distribution of turrets, experience during maneuvers with the British *Nelson* and *Rodney* has demonstrated its dangers, and in a running fight with the enemy astern these ships were unable to return fire.

The 15 6-inch guns which will form their secondary armament are in five triple turrets, two on each side and one on the center-line over the hangar aft. Between these are twin 3.9-inch anti-aircraft guns and a larger number of smaller sky guns are distributed over the superstructures. Four planes are stowed in the hangar which extends onto the quarter deck, with two catapults.

Nothing so imposing as the bridge-tower has ever been erected on any warship. As now contemplated, it will be a huge, almost triangular, structure with the blunted apex forward carrying a crown of range-finders. In the British *King George V*, the tower contains the conning tower; in the French *Richelieu*, this is seen rising through a two-decked bridge at its forward base. In the drawing, note the searchlights on control towers abreast the funnel and the curious pagoda of controls, aft, from which arises the main mast.

The total weight of armor is just over 15,000 tons, the heaviest proportion to displacement yet assigned to any capital ship so far as is known. From the forward turret to the after 6-inch triple, the belt is 16-inch with 9-inch continuations to bow and stern; turrets are 16-inch face and 14-inch side armor; and the upper and lower armor decks total 8 inches—a truly wonderful carapace against vertical attack! With but six high-pressure boilers, the horsepower is 155,000, giving a speed of 30 knots and more; the funnel so close to the tower is likely to prove troublesome in a following wind. The *Richelieu* will be ready in 1939, the *Jean Bart* in 1940, and *Clemenceau* and *Gascogne* in 1941.

The present rapid increase in the German Navy is now of especial interest in America as the Chancellor aims at regaining the former colonies of the Reich which would allow for the development of naval bases on the west coast of Africa within striking distance of the American continent. In the event of a successful campaign in Europe, this aim might be achieved, in which case an alliance with Japan would consolidate the German plans to extend her interests in South America. For the present, there is an agreement by which the Reich limits the construction of surface vessels to 35 percent of the British Navy with an elastic interpretation as applied to the submarine arm. But Germany has learned by experience that in a short war she would not need to have command of the sea so far as surface ships were concerned; a big and efficient submarine fleet would play more havoc with the British Empire than a ratio of more than 35 percent of battleships and cruisers. And present-day German strategy does not aim at keeping a great fleet standing by



The German 35,000 tonners, now building, have immense beam and massive protection. Absence of main mast permits anti-aircraft cross-fire

France's "Richelieu" has two quadruple turrets of 15-inch guns. Note great conning tower surrounded by bridgework, and huge tower mast supporting the control positions aft

in North Sea harbors for coast defense purposes. Her new capital ships are to be sent out in company with carriers and cruisers to prey upon shipping, and the main problem of the British battle fleet will be to try to prevent such forces from slipping through the northern exits from the North Sea in fog and darkness.

For this reason she has given her *Scharnhorst* and *Gneisenau*, just completed, a speed of 27 knots, and aims at 30 knots or more in the 35,000 tonners now building. Both Germany and Italy are responsible for introducing high speed into battleships, thereby greatly increasing their size—as speed demands length unless power is to be increased out of all proportion to displacement—their cost, and their individual asset value. The first of these 35,000 tonners, the *Bismarck*, was launched about four months ago and the second, the *Admiral von Tirpitz*, on April 1; the third was laid down last year; and a fourth is projected and likely to be commenced during 1939. They will be 792 feet long —40 feet longer than the American and British designs—with the colossal beam of 118 feet and only 26 feet mean draft to allow for shallow North Sea work. Such a beam means immense docks but will permit of under-water subdivision never before attempted, which should give near-immunity to torpedo attack.

Under the Versailles Treaty, the biggest gun permitted in the German Navy was 11 inches on a displacement limited to 10,000 tons. These restrictions produced the famous *Deutschland* class, able to outsteam all battleships and outgun all cruisers. In the two *Scharnhorsts*, just completed, displacement was raised to 26,500 tons to provide adequate protection for a hull carrying nine 11-inch guns as a main armament. Hence they will be able to work in concert with the *Deutschlands* and utilize the guns already built.

In the new 35,000 tonners there was no question of following the British example with 14-inch guns, and in a single step the Marine Amt decided to go one better than the *King George V* class now building. There will be two turrets fore and aft carrying 15-inch guns with 12 6-inch guns amidships in four twin- and four single-gun positions. Fourteen 4.1-inch anti-aircraft guns are to be spaced a deck higher, six aside amidships and a pair aft firing over the third turret. This arrangement makes for an undue concentration of small guns around the base of the funnel, where they are extremely vulnerable; it is possible that the catapult will be moved to the quarter deck to allow for more generous spacing of the smaller guns.

The Germans favor a moderate freeboard with a marked sheer towards the bows, and are "small-target" ships. Geared turbines, in combination with Diesels and very high pressure boilers, allow for a single funnel with a broad trunk base around which is built a searchlight platform serving as a support to a light tripod pole mast for the radio aerials. By keeping the rig forward of amidships, the anti-aircraft guns have unobstructed arcs of sky bearing, which is really only evident upon observation from the decks of the *Scharnhorst* or *Leipzig*.

NO details as to protection are available, but it may be taken for granted that the armor allowance will be as generous as in their contemporaries and fully utilized to the last ton and maximum advantage.

After considerable delays, Italy's first modern battleships, the *Littorio* and *Vittorio Veneto*, will be ready for sea this summer and their trials will be watched with considerable interest as their engines are designed for 160,000 horsepower—the highest ever installed in warships barring the U.S.S. *Saratoga* and U.S.S. *Lexington*. This power is intended to realize 32 knots, and Parsons geared turbines have been installed instead of the Belluzzo type fitted in battleships recently reconstructed. Such a speed makes the category of "battle cruiser" superfluous, and is in keeping with the very high rates of steaming recorded by post-war Italian cruisers and destroyers.

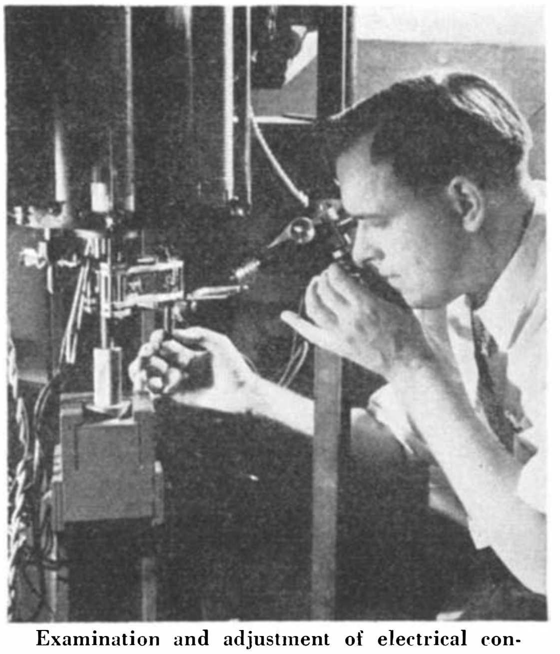
The four ships of the *Littorio* class are 774 feet long with a beam of 103 feet and a mean draft of 28 feet, giving the standard displacement of 35,000 tons common to all the battleships under review. The three turrets house triple 15-inch guns, and at the four corners of the superstructure are smaller triple 6-inch turrets, with three pairs of 3.5-inch, anti-aircraft guns between them. Twenty smaller sky guns are carried and may be seen nested on the turret crowns and hangars. With such an armament and speed, there has had to be some sacrifice in protection so that the main belt is reduced to 9 to 12-inch, and the turret and deck armor should be proportional to this.

The foremast is a cone crowned by the big range-finder and surrounded by bridgework, with an unusually heavy tripod aft carrying searchlights and anti-aircraft guns; abreast the fore funnel are the hangars, with catapults along the edge of the boat deck amidships. Italian constructors now favor two funnels when possible, as a bad hit on a single stack would seriously affect furnace draught and these two ships, with the *Roma* and *Impero* now on the stocks, will have the same general profile as the four reconstructed *Cavours*, the funnels being of unequal height with cutaway black caps which are said to assist in keeping the fire control clear of smoke in a following wind.

Presumably intended for hit-and-run operations, the four ships of the *Littorio* class will present a very serious problem in the Mediterranean although it is anticipated that Italy will depend upon small craft rather than expose her battleships to the risks of a fleet action.

HOW METALS RELAX

Research Engineers Demonstrate that Metals Stretch and Lose Their Grip with Time and High Temperature



Examination and adjustment of electrical contacts of the unique automatic relaxation machine

STEEL bolts and rivets creep and relax, research engineers have reported at the conclusion of a three-year investigation at the Westinghouse Research Laboratories.

The investigators have invented an automatic relaxation machine which determines within a few hours how much metals will relax in many years. Engineers A. Nadai and John Boyd have been heating, stretching, and "relaxing" copper and steel to discover how and why bolts eventually lose their grip under high temperatures.

This habit of metals to relax has long been a problem in great steam turbines where heat is converted into power to run the machines of the modern world. The problem comes closer home to the average person when the garage man finds that the bolts in the motor head of his automobile are loose. The unseen cause of the loosening is creep and relaxation resulting from the heat of the automobile engine—two phenomena characteristic of all metals, particularly at elevated temperatures.

"So far as we know, there exists no metal which does not display this deformation characteristic," observed Dr. Nadai. "If sufficient time is allowed, all metals and any other solids will creep or deform under continuous loads, even at low room temperatures."

When an engineer designs a steel bridge, he can calculate the stress and strength of the steel and know how his bridge will be able to carry a definite load 100 years from now. But when an engineer designs a steam turbine, he must take the effects of heat into consideration because the temperature will determine the effective life of his machine. Temperatures have steadily climbed upward in modern steam turbine applications until today the steam pipes of a turbine in a modern central power station start to glow at heats of more than 1000 degrees, Fahrenheit.

But if the steel used does not creep more than one one-hundred-millionths of an inch during every hour of the life of the steam turbine, the engineer is satisfied that its life expectancy will meet present practical requirements. This "permissible" amount of creep figures out to be one one-thousandth of an inch over a period of ten years.

When a bolt is tightened into place, it is actually stretched in the tightening process since a stress sometimes as high as 60,000 pounds to the square inch is applied. While held in this position the bolt is not permitted to contract but its stress gradually decreases; that is, the bolt relaxes its hold in time.

Consider a spring as another illustration. When it is stretched out and released, it springs back to its normal position. But if the same spring is stretched and then heated at a high temperature, it will not spring all the way back to its original position. It has been permanently deformed and its elastic strain has been gradually transformed into a permanent plastic strain or deformation.

The investigators used copper bars in attempts to discover the secrets of relaxation. They selected copper for the first tests because of its importance in electrical machinery and its purity as a metal. They loaded the test pieces with weights, maintained the temperature in the room at 77 degrees, Fahrenheit, and charted the amount of stretch.

NEXT, identical test bars were placed in a relaxation machine where, this time, the load was automatically lightened to maintain the bar at a constant length. It was discovered that the results of the creep test and the relaxation test could be closely correlated. Thus it is possible to predict the rapidity of copper's relaxation at room temperature by studying the creep, or vice versa.

At room temperature, copper will hold its own for a good many years without appreciably losing its grip. On the basis of these tests, the investigators calculated that a copper bar starting with a stress of 19,850 pounds to the square inch would relax only to 12,600 pounds of stress in a 20-year period, provided the temperature did not exceed 77 degrees.

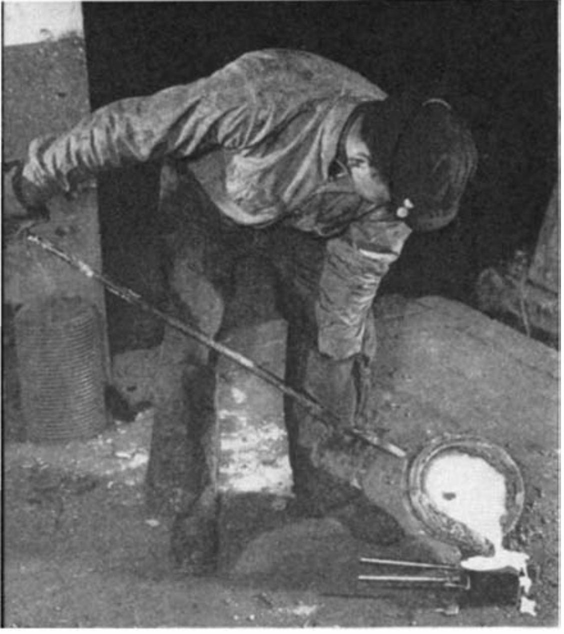
But at a temperature of 350 degrees, Fahrenheit, copper would relax from 19,200 pounds stress to 2000 pounds during this same period. The relaxation was so rapid that the test bar would be unloaded perhaps after a few minutes if the temperature were shot up to 500 degrees, Fahrenheit.

Even steel, much harder than copper, would relax 60 percent from an initial stress of 11,750 pounds if maintained at a temperature of 850 degrees for 20 years, the tests disclosed.

Several additional experiments showed that by frequently retightening a steel bolt when it became loose, it was possible to strengthen it and increase its resistance to relaxation.

These discoveries have convinced Dr. Nadai that "our engineers must find the new laws" underlying the phenomena of creep and relaxation, "if the engineers are to continue their steady advance in making steam turbines ever more efficient power producers." He pointed out that "the theory of elasticity is the base of all engineering design now taught in the schools, but no adequate theory of creep yet exists."

Both men expressed confidence that the invention of the automatic relaxation machine is a step toward creation of such a theory. The apparatus is so designed that a metal test sample is weighted by a spring which is stretched by a worm drive connected to a motor. While an electric furnace heats the test piece, sensitive electric contacts operate the motor to adjust the load and maintain the sample at a constant length despite the stretching of the metal.



The first step in the process is the pouring of a sample from the molten metal into a hand mold

CONTROLLING

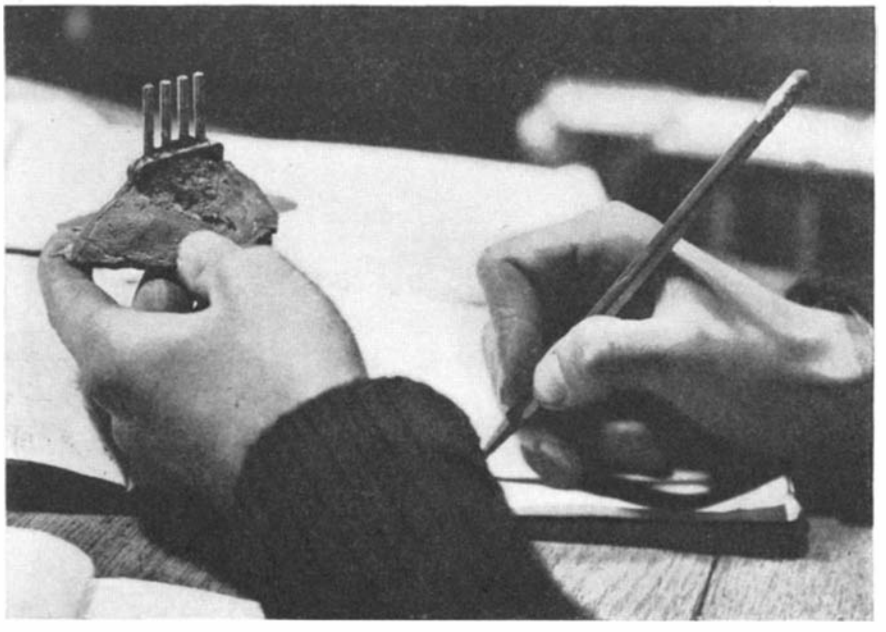
THE method by which astronomers discovered helium on the sun before it was known to exist on the earth has been put to work to help make better alloy iron and steel in the Ford Motor Company's foundry. The method is spectrographic analysis, and it enables the metallurgists to know that each "heat" of the metal is right before it is poured.

The new analytic method has been in operation long enough to show that it is both faster and more accurate than the chemical method it supplements. It quickly shows the important elements in each heat and the proportions of each. This permits closer control over the molten foundry iron and steel, and means that uniform quality is constantly maintained.

Asked to explain the basis of the method, one of the metallurgists pointed out that salt thrown on a flame causes it, because of the sodium it contains, to burn with a yellow color.

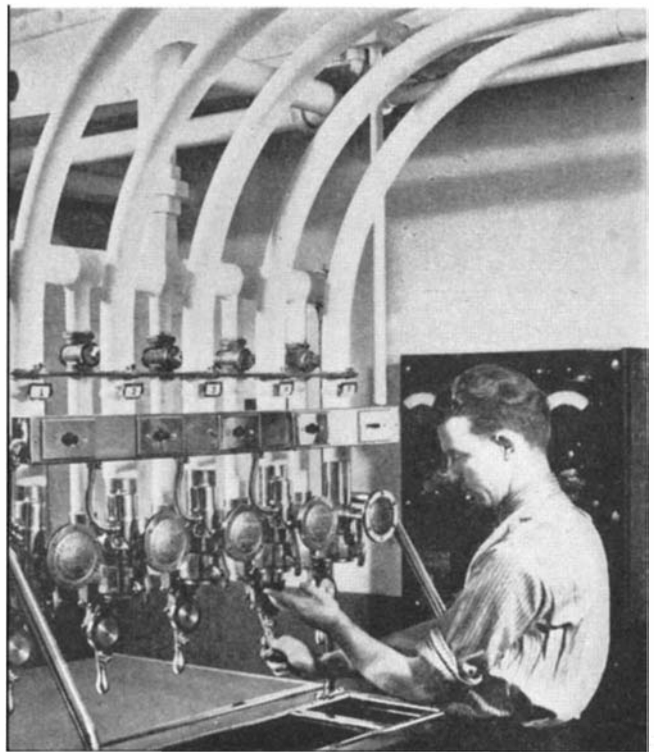
"When burning, each of the other elements has a characteristic color, although many of these colors are invisible to the human eye," he said. "To be able to 'see' the colors—and in that way identify the metals in an alloy—we burn the alloy in a spark-gap and, with a prism, break up the light it gives off into a 'rainbow,' or series of spectral lines. We photograph this pattern of lines. By studying the photograph we learn what metals are present in the alloy. By measuring the density of the lines by a very delicate microphotometer we can tell the proportion of each element."

For routine analysis in the Ford foundry, a foundryman pours a special little casting which is sped about 1600 feet to the spectrographic laboratory in a pneumatic tube like those used in department stores to transfer change. A laboratory assistant grinds one end to make it bright, and inserts the sample in the 40,000-volt spark-gap.



The tiny casting is quickly cooled and removed from the mold, and a complete record then made of it

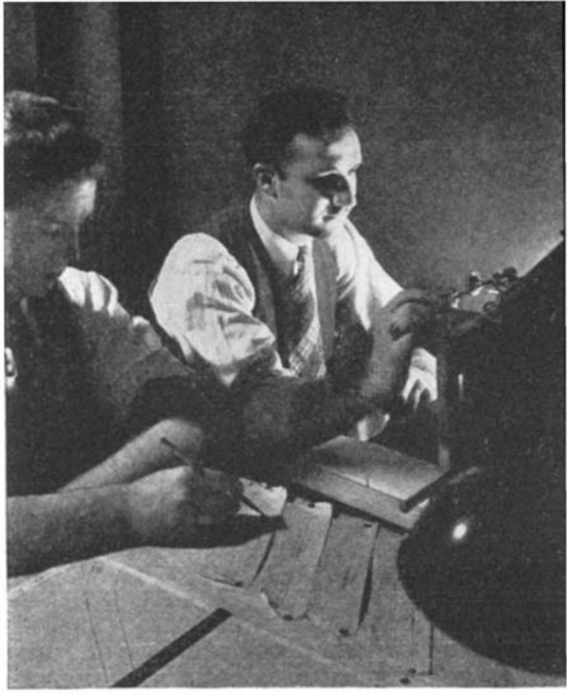
The third step in the process: The sample is sent for a ride through a 1600-foot pneumatic tube to the laboratory



After one end of the sample has been ground in the laboratory, it is placed in a 40,000-volt spark gap, has its spectrum snapshotted

THE 'HEAT'

Complete Analysis of Industrial Iron, Steel by Spectrographs . . . Made During the "Heat" in Few Minutes . . . Necessary Alloying Elements Then Added



Percentages of elements are quickly computed and a report sent to the foundry to guide the foreman

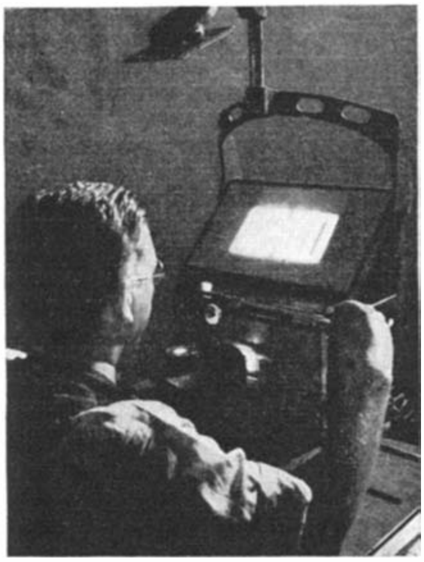
Light from the spark-gap goes into the spectrograph, where the prism breaks it up into the spectra mentioned above. The photograph is quickly developed and then analyzed in the microphotometer, which was especially developed, by an application of the "electric eye" principle, for the work. Within 10 minutes, or even less, from the time the sample is poured, the report has been sent back through the pneumatic tube to the foundry foreman. He then orders silicon, chromium, copper, molybdenum, manganese, or nickel added in just the quantities needed to bring that heat precisely up to specifications. Then it is poured.

IN addition to close control of quality, the spectrographic method opens up new avenues for research into the characteristics of metals. It also gives the metallurgists a swift method for identifying unknown elements in a mixture and performing similar jobs which are often extremely tedious by chemical methods of analysis.

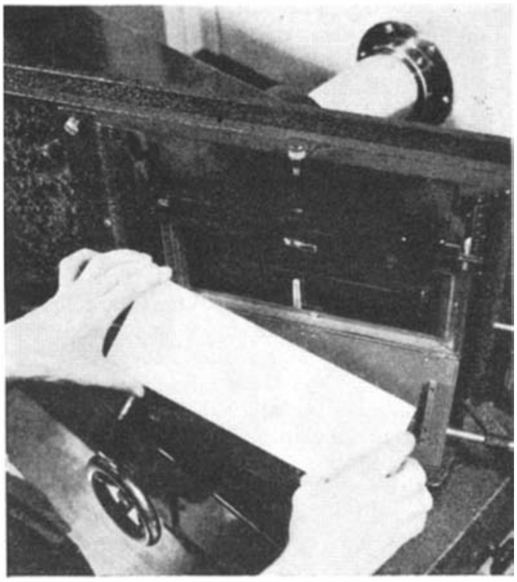
As done in the Ford spectrographic laboratory, nine samples may be analyzed simultaneously for six different elements, a total of 54 quantitative determinations, all in a few minutes. The great value of this speed, in a foundry that pours several hundred tons of cast iron and cast alloy steel a day, is obvious.

Practical application of the spectrographic method to routine control of foundry output was the work of Messrs. H. B. Vincent and R. A. Sawyer of the department of engineering research of the University of Michigan. Its first foundry application was in the Campbell, Wyant & Cannon Foundry at Muskegon, Michigan; and experience gained in the operation there, dictated the changes and improvements incorporated in the Ford spectrographic laboratory. It is the world's most advanced laboratory.

Of particular interest to photographic fans is the method used for drying the plates on which the spectral lines are photographed. Time for processing the plates, of course, must be held to a minimum if the speed of the method is not to be largely lost in the dark room. A high-contrast, fine-grain plate is used. After a quick trip through the developing and fixing tanks it is rinsed in distilled water, making sure no minerals which might affect the density of the spectral lines remain. It then is dried in about 30 seconds in a special "toaster" consisting of an electric heating element and a blower, and sent to the microphotometer for analysis.

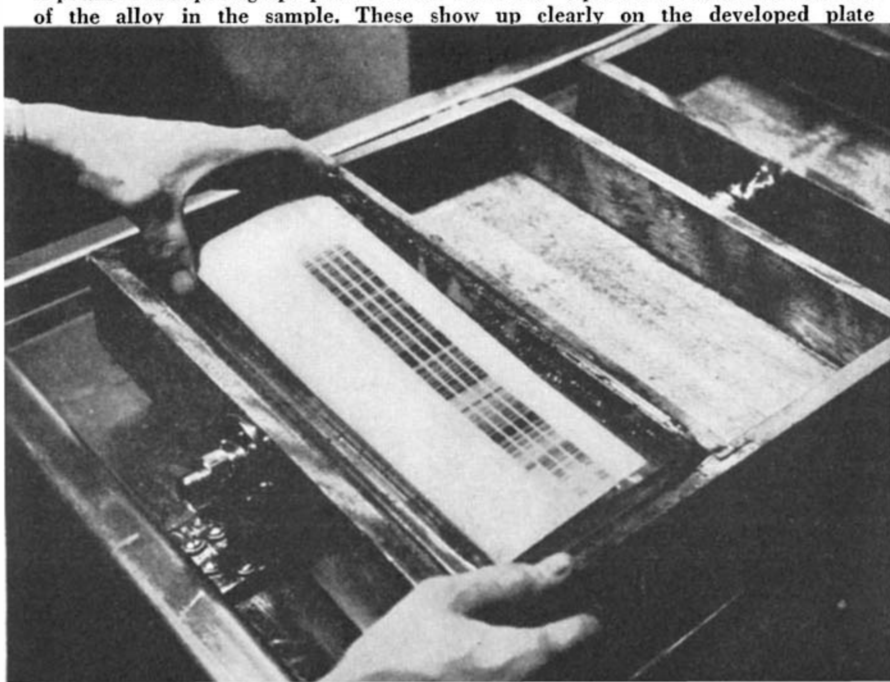


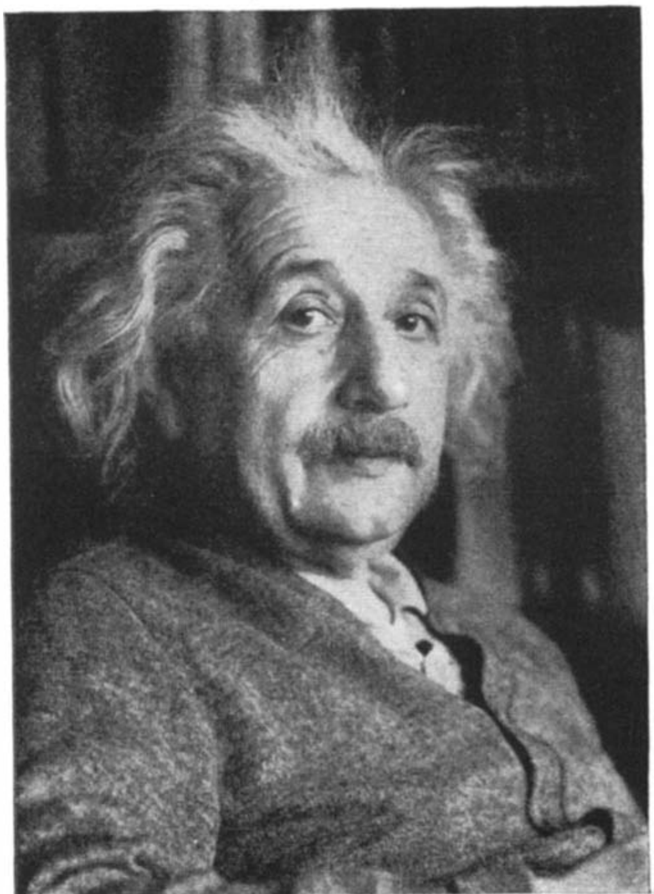
The spectrographic plate is then examined in a microphotometer



Light from the spark is sent into a spectrograph which contains a photographic plate

A prism in the spectograph produces the "rainbows" (spectral lines) of the elements of the alloy in the sample. These show up clearly on the developed plate





Taken especially for Scientific American, by Betty Menzies

Professor Einstein at home in his study

Relativity—

(Part One)

The Special Theory

TWENTY years ago, the world, emerging from that cataclysm in whose dark shadow it is even yet engulfed, was electrified by the predictions of a scientific theory of unparalleled boldness, the general relativity theory of Albert Einstein. Hailed as a revolutionary theory, in a field in which heterodoxy then seemed to entail no objectionable sociological implications, it constituted for many a pleasant escape from the war's sordid aftermath of recrimination and disillusionment. Public interest in relativity and its spectacular astronomical consequences was heightened by the journalistic fable that there was, according to its author, but a handful of specialists capable of understanding the theory—a fable branded by Einstein himself as one "invented as a consolation for those too lazy to think!" A hundred books and a thousand articles—a good majority designed for the consumption of "the man in the street"—were written before public interest waned in favor of Tutenkhamon and things Egyptian, a fad more easily adaptable to the fashions of accoutrement and coiffure.

But those who followed more closely the development of the general theory of relativity knew that behind it lay Einstein's 1905, or special, theory—the historical, if not the logical, background of the more spectacular theory of gravitation. In many ways of greater importance for the general body of physical knowledge, the special theory was the logical outcome of decades of conflict between the classical mechanics and the growing body of optics and electromagnetic theory. Strange as it seemed at first, with its surrender of the concept of absolute simultaneity, it underwent a steady development and clarification in the decade following its inception. The striking paradoxes to which it gave rise, most illuminatingly resolved during this period by the revolutionary space-time geometry associated with the name of its distinguished exponent Minkowski, seem to have attracted but little attention outside the circle of scientists who concerned themselves with fields directly affected by the theory.

By 1918 the special theory was firmly established on the solid base of experimental findings, and, although logically independent of the general theory, it was thoroughly incorporated as a special case into the latter more embracing doctrine. It, too, then came into its share of general interest, especially in view of its renunciation of the absolute time so universally employed by its predecessors, and the paradoxes—such as that of the traveling twins—to which this renunciation gave rise.

What, then, has been the fate of these two theories during the past two decades—the special theory itself, and the more inclusive theory of gravitation? What of the speculative theory of the "expanding universe," which has been grafted onto the general theory during this time? And what credence is to be given the vitriolic attacks launched recently on the theory and its author by those fanatics who would reform physical science along the lines laid down by political or racial dogma? To answer these questions and, more, to follow the unfolding of these theories during the past 20 years, is the purpose of this article. Let us begin with a review of developments in the special theory, as the question of its validity is quite independent of the validity of the later general theory—although the converse of this statement is not true.

First, we consider the status of the historical Michelson-Morley experiment, which has undoubtedly served, more than any other single experiment, to initiate that train of thought which was to culminate in the special theory of relativity. As pointed out by Maxwell in 1878, if light is propagated through a stationary ether with a constant velocity, then the motion of an observing apparatus through this medium should give rise to optical effects which would, in principle at least, enable the observer to determine his velocity with respect to the ether—light should under these circumstances take longer to travel a given distance *down* the ether stream and back than to travel the same distance *across* and back, a discrepancy which should be observable with the aid of a suitably designed apparatus for the detection of interference between the two re-united beams. And, since the Earth is traveling around the sun with a speed of 30 kilometers per second, in the most unfavorable case its maximum velocity relative to the hypostacized ether must be at least this large—unless the ether is substantially entrained by the matter composing the Earth, in which case there would be great difficulty in explaining the well-known phenomenon of aberration of light from the stars. In spite of the minuteness of this "second order" effect—depending only on the *square* $(v/c)^2$ of the ratio of the velocity v of the observer to the velocity c of light—its detection seemed well within the range of observational technique. Experiments on this effect at the Case School of Applied Science in Cleveland, carried out by Michelson and Morley in 1887 and by Morley and Miller around 1905, failed to reveal this predicted effect; their results were, at the beginning of the period covered in this report, generally taken as a confirmation of the theory of relativity, according to which there should be a null-effect. But in 1925 D. C. Miller announced that a careful repetition of the experiment on Mt. Wilson showed, not the predicted result, but one which he could explain only by assuming that the solar system was moving some 200 kilometers per second through the light-bearing medium, and that this medium was entrained by the Earth to such an extent that the relative velocity in the interferometer house on Mt. Wilson was reduced to a mere 10 kilometers per second. As such an effect would be extremely difficult to explain by a modification of the classical theory, and presumably impossible on the relativity theory, the question of its existence became of great importance.

LATER experiments by Kennedy and Michelson on Mt. Wilson and Joos in Jena failed to show the effect, although

20 YEARS AFTER

An Evaluation of the Achievements of the Special and General Theories of Relativity During the 20 Years which Have Elapsed since the First Direct Observational Test of the General Theory

By H. P. ROBERTSON, Ph.D.
Professor of Mathematical Physics, Princeton University

PROFESSOR Einstein published his special theory of relativity in 1905, but the public did not discover it. He published his general theory of relativity in 1915, but the world was preoccupied with its Futile Quarrel and again failed to give notice. An eclipse of the Sun that took place on May 29, 1919, first focused press and public's thoughts strongly on relativity, because this afforded the first actual observational check on the general theory. This present month, 20 years after that pivotal date, is chosen to offer our readers an estimate of the present status of relativity. The author has specialized in this branch of mathematical physics.
—The Editor

the apparatus employed by the former and the latter should have been capable of detecting a relative velocity of as little as one kilometer per second! Miller's suggestion that this null-effect might be explained by assuming that the more substantial housings in which these experiments were performed might be responsible for a further entrainment of the ether, seems untenable in view of the most simple and ingenious experiment performed by Hammar of Idaho in 1934. Hammar reasoned that such an explanation would lead to an easily detectable "first-order effect" (depending on the ratio v/c itself) if one arm of the interferometer were encased in a heavy tube; with such an apparatus, capable of showing a differential entrainment of one kilometer per second, no such effect was observed. That the highly mystifying effects predicted by the Englishman Hicks, Cartmel of Montreal and others, due to imperfect alinement of the apparatus, are in fact spurious was shown by the more complete analysis published by Kennedy in 1935. The bulk of the evidence is thus directly in favor of the null-effect, and hence indirectly in favor of the relativity theory, although a completely satisfactory explanation of the outstanding exception, the Miller experiments, has not to date been given. One interesting possibility which has been suggested is that Miller did not adequately allow for magnetostriction, due to the action of the Earth's magnetic field on the interferometer base, but to my knowledge no independent analysis of the data, with this feature in mind, has been carried through.

A DIRECT confirmation of the validity of the second order term in the relativistic expression for the Doppler effect was announced last spring by H. E. Ives of the Bell Laboratories. By an ingenious arrangement of mirrors Ives was able to observe the Doppler shift in an oncoming hydrogen beam, and at the same time the shift due to the recession of the same beam; on comparing the center of gravity of these two shifted beams with the undisplaced line, the predicted term was verified, although the displacement was just about at the limit of the resolving power of the optical system.

Surprisingly enough, the keen analysis earlier last year by Zahn and Spees, of Ann Arbor, of the fundamental experiments of the German physicists Bucherer and Neumann, long accepted as establishing the relativistic variation of mass with velocity, shows that they actually prove little more than an increase of mass, as the resolution in these older experiments is too poor to give quantitative results. Because of the general belief in the validity of these original experiments, little, if any, advance in this direction has been made since their performance—with the result, as emphasized by Zahn and Spees, that "in view of the fundamental importance of such experiments it seems that much is left to be desired." It is to be hoped that this challenge will soon be met, and that, with the aid of modern technique, we shall obtain a surer knowledge of this effect for particles of high velocity.

Another result skirted upon by electromagnetic theory, and more definitively expressed by relativity, is the equivalence of mass and energy. This effect, which has long been speculated upon as a possible—perhaps the only possible—source of stellar energy, has been employed as one of the most important theoretical tools in the recent developments in nuclear physics. The consistency of the modern table of atomic weights, usually given to four places after the decimal point, under nuclear transformations may be regarded as a most valuable indirect confirmation of this equivalence. This growing body of knowledge gives great promise of yielding an evolutionary interpretation of the main features of the Russell diagram relating the luminosity of a star to its type—a promise the fulfillment of which has been materially furthered by the recent work of Bethe of Cornell, and of Gamow and Teller of George Washington. Thus the former would consider the stars of the "main sequence" as fed by the energy liberated on the combination of protons and electrons into an α-particle, the by-product of a lengthy chain of nuclear reactions involving carbon and nitrogen.

Finally, the greatest single triumph of the special theory during the past 20 years is its immense importance for the theory of atomic structure. At the beginning of this period it was employed, with great success, by Sommerfeld of Munich to explain the observed fine structure of the hydrogen spectrum. This was followed by the seven lean years prior to the development of modern quantum mechanics, in which the attempt to explain the structure of other spectra was frustrated in large part by the fact that the alkali doublets, whose separation was of the same order of magnitude as this relativistic effect, could for other compelling reasons not be so interpreted. The resolution of this dilemma by the semi-empirical introduction of the electron spin, by the Dutch physicists Uhlenbeck and Goudsmit, and the derivation by Dirac of Cambridge of the spin from accepted principles of quantum and relativity theories alone, constitutes one of the greatest chapters in atomic theory.

IN view of these developments one may say that at present the special theory of relativity is one of the most thoroughly accepted and most firmly established doctrines of modern physics. It has permeated the fields of mechanics, electromagnetism (including optics) and atomic physics; while it may appear desirable to have further direct checks on the validity of its mechanical aspects, a deviation from the predicted effects would constitute a most puzzling—and, at least temporarily, distressing—jolt for modern physics.

(Part Two—*The General Theory*—will appear in July)

RAILROADING'S LATEST CHAPTER

One of the two identical units of the new Union Pacific Steam-electric locomotive. Units may be operated separately or together. Note the engineer's high perch

STEAM is riding the rails in a new manner!

Instead of directly driving the wheels, as it has done in reciprocating steam locomotives for the past century, steam has been harnessed to function at increased temperature and pressure through small but amazingly powerful turbines installed in a locomotive. And the turbines—little brothers to those installed in modern power plants throughout the country—rotate generators to furnish the energy for electric motors to drive the locomotive.

This is the radically new steam-electric locomotive built by the General Electric Company for Union Pacific's fast passenger service between Chicago and the Pacific coast. It can haul a 12-car passenger train over the 2.2 percent grades encountered on that run and will operate safely at speeds up to 125 miles per hour. It will do twice the work of the conventional steam locomotive for the same amount of fuel. The first locomotive of its kind in the world, the steam-electric locomotive introduces another type of motive power to rail transportation, and opens a new chapter in the romance-studded history of American railroading.

Just ten years more than a century ago, Horatio Allen, who had been at the throttle of the *Stourbridge Lion* on its first trial run in this country, summed up a report to the South Carolina Railroad on the respective economies of steam locomotives and horses with the following words:

"There is no reason to expect any material improvement in the breed of horses, while in my judgment, the man is not living who knows what the breed of the locomotive is to place at command."

The "breed" of the locomotive has certainly lived up to and far outdistanced the possibilities foreseen for it by Allen. And his comment is still true of any type locomotive in service today.

STEAM transportation, introduced to this country by the imported English *Stourbridge Lion* in 1829, still provides the mainstay of motive power for the American railroads. Of the 45,000 locomotives now in service in our country, all but a small percentage of them are of the reciprocating steam type. Since the *De Witt Clinton* hauled its first train on August 9, 1831 over the 17 miles between Albany and Schenectady in the time of one hour and 45 minutes, continuous development and improvement of the steam locomotive has been taking place.

It was not until 1895 that a new type of motive power appeared on the scene to challenge the reign of steam in rail transportation. In that year the Baltimore and Ohio began operating the first standard railway electric trunk line. At the time there were many who predicted the electric locomotive would soon replace the then well-established steam locomotive. But it soon became apparent that the electric locomotive could be used economically only where there was sufficiently heavy main line traffic to justify the expense of erecting and maintaining a costly overhead power system.

Steam's latest important competitor came along in 1934 in the form of the Diesel-electric locomotive and Diesel railcar. In that year the Chicago, Burlington and Quincy Railroad put its lightweight, articulated *Zephyr* into service between Kansas City, Omaha, and Lincoln. In a short time, the Diesel-electric locomotive became synonymous with speed and modernity in rail transportation. The sleek, richly appointed Pullmans and passenger coaches which were flashed across the country by Diesel-electric locomotives quickly captured the imagination of the American public. Air conditioning, introduced at about the same time and included as standard equipment on all of the newly built Diesel-electric trains, made them ever more popular. Here was real competition for the time-honored iron horse! So real was it, in fact, that immediate steps were taken to maintain the prestige of the steam locomotive.

Interior of the cab showing simplicity of controls and operator's chair

In 1935, two streamlined steam locomotives were produced to pull the "Hiawatha" trains between Chicago and Minneapolis at greatly increased speeds. Now streamlining has become the fashion in steam as well as Diesel-electric locomotives, and of the 43 streamlined locomotives produced in 1938, 25 were steam; 18 were Diesel-electric.

The biggest advantage of the Diesel is its high availability. It can be maintained in continuous service for longer periods than the steam locomotive without stops for rest and overhauling and

Steam and Electricity Co-Starred . . . New Locomotive Has Advantages Over Present Motive Power . . . Thermal Efficiency High . . . Unique Features

By C. P. FISHER, Jr.

can travel greater distances without stopping for fuel or water. The cost of Diesel operation will not exceed two thirds of that for an equivalent steamer.

But initial cost still favors the steam locomotive. It costs only one quarter to a third the delivery price of a Diesel-electric of equal power and speed. The Diesel, however, has greater tractive effort at low speeds. For that reason it has become extremely popular in switching service on railroads and in industrial plants.

No comparison is available as yet on the operating or maintenance costs of the new steam-electric and Diesel-electric types of locomotives, but it is expected that those of the former will be lower. The steam-electric locomotive has its fuel fed into a fire box rather than into a combustion engine and for that reason can burn a very low-cost petroleum, known as "bunker C" oil.

One of the two main drive turbine and gear units being assembled

In essence, the steam-electric locomotive combines the inherent advantages of both the reciprocating steam locomotive and the straight electric locomotive, plus the reliability, efficiency, and compactness of the steam turbine, a prime mover proved beyond a doubt in thousands of central stations. The steam turbine has no reciprocating parts, no lubrication difficulties, and when properly applied is most efficient in the use of fuel. It is this combination of the proved advantages of the steam locomotive, the electrical locomotive, and the steam turbine which makes the steam-electric locomotive most interesting.

DISCUSSIONS of plans for building the steam-electric locomotive were taking place even before the Diesel-electric locomotive loomed as a factor in the transportation industry. Space limitations presented one of the principal problems in building the steam-electric locomotive. A steam turbine for a power plant might sprawl out to any reasonable proportions, but there were definite limitations in building one to generate power in a locomotive. Locomotives' dimensions are restricted because of clearance requirements of bridges and tunnels. Length cannot exceed that point at which flexibility for rounding curves is lost.

The Union Pacific steam-electric locomotive consists of two identical units, each 90 feet 10 inches long, weighing 530,000 pounds, and rated 2500 horsepower. Each is complete in itself and may be operated individually as an independent locomotive, or the two may be operated in multiple under the control of a single operator. As an incidental point of interest, this is the first time in the world that two steam-powered locomotives have been operated in multiple unit.

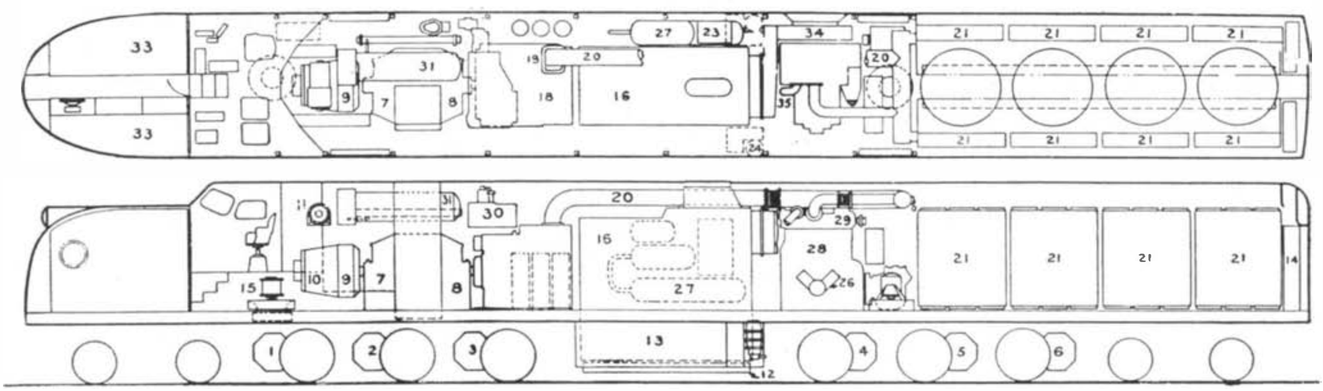
View inside the cab nose showing some of the train control equipment

The sides and roof of each unit are of sheet aluminum, eliminating unnecessary weight, although the noses of the cabs are of ordinary carbon steel. The cab-frames are built of high-strength steel tubular members.

Each motive power unit not only supplies the rated 2500 horsepower for traction purposes, but also supplies the power for auxiliary electric power throughout the train, as well as the steam for heating the trailing coaches.

The main turbine set of each cab is self-contained with high- and low-pressure units mounted on a common base

(*Please turn to page* 388)



Compact arrangement of the equipment in the new steam-electric locomotive. By the numbers: 1 to 6, traction motors; 7-8, main generators; 9, alternators; 10, exciter; 11, battery charging set; 13, main control contactors; 14, battery; 16, boiler; 18, high-pressure main turbine; 19, low-pressure main turbine; 20, exhaust header; 21, air-cooled condensers; 23, high level condensate tank; 28, boiler auxiliary set turbine; 30, compressor; 31, train heating evaporator; 33, raw water tank. This concentration of equipment, unique in its conception, had to be carried out under rigid dimensional limitations

SULFANILAMIDE AND SULFAPYRIDINE

Now that Enough Time has Elapsed to Permit Calm Estimate of These Newly Developed Drugs, How and Where do They Stand in the World of Medicine?

By BARCLAY MOON NEWMAN

GREAT discoveries in chemotherapy are rare. For all the prodigious efforts spent in the attempt to discover drugs having marked action in germ diseases, today there are only a few great specifics, such as quinine for malaria and the arsenical for syphilis.

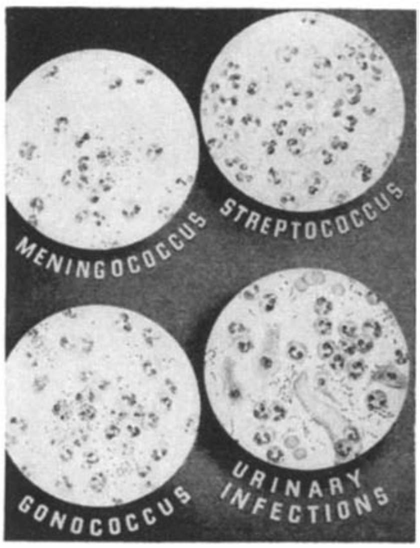
We must then regard recent progress in the development of powerful chemotherapeutic agents as the opening of a new era. Within less than four years, two chemical agents of outstanding value to medicine have been introduced.

One, sulfanilamide, has gained established application in treating, often curing, a number of acute infections caused by particular strains of bacteria—the so-called beta hemolytic streptococci of erysipelas, childbirth infections, blood infections (septicemia), septic sore throat, meningitis. And it has revolutionized the treatment of gonorrhea. It may or may not turn out to be beneficial in certain types of pneumonia, though conservative investigators are doubtful.

The other, sulfapyridine, a derivative of sulfanilamide, already appears to rival, if not surpass, sulfanilamide's established values. Moreover, in severe infections caused by that most common pus-producing organism, the golden-yellow staphylococcus, sulfapyridine has unique effectiveness. In pneumonia, despite press and radio publicity, sulfapyridine's future is unknown, though promising at present. English clinicians are far more optimistic. Yet the new rabbit and horse serums must remain the most effective pneumonia treatment.

WHETHER or not pneumonia therapy is advanced through these new drugs, both of them are specifics of rare importance. The discovery of sulfapyridine so soon after the introduction of sulfanilamide indicates that in this group of chemical compounds we have molecules exhibiting priceless physiological activity. Where one derivative of sulfanilamide is so potent, there must be other derivatives as powerful in their therapeutic action, not only against the bacteria already brought largely under control but against other germs. Study of sulfanilamide and its kin molecules brought sulfapyridine. Further studies will probably give man additional weapons against his subtlest enemies.

The existence of the sulfanilamide (para-amino-benzene-sulfonamide) molecule was discovered in 1908, by dye chemists. In 1913, the possibility of using such dye molecules in chemotherapy was suggested, and a number of these substances were subsequently found to have limited value as anti-bacterial agents. In 1935, German scientists, guided by G. Domagk, determined that prontosil, which contains the sulfanilamide structure, is effective in streptococcus infections in mice. The use of prontosil was



Some of the bacteria against which the new drugs make successful war. The bacteria are the tiny dots

promptly extended to man, in clinics throughout the world. Finally, the most active fragment of prontosil was shown to be para-amino-benzene-sulfonamide, or sulfanilamide. Prontosil and a derivative, neoprontosil, however, do seem to have certain unique applications in this field, where sulfanilamide and sulfapyridine are not quite so efficacious, and also are considered by most investigators to be as valuable in general as the less complex molecules.

There are three forms of bacteria: rods, spirals, and globules—all microscopic. The globules are cocci. Cocci which characteristically multiply so as to produce chains of globules are streptococci. Staphylococci are those forms which reproduce so as to give rise to clusters of individual bacteria.

Streptococci are man's worst bacterial enemies. They are found practically everywhere, hence are an ever-present menace. And they cause a greater variety of infections than any other type of bacteria. The most dangerous streptococci are the hemolytic—those with destructive influence on the red corpuscles of the blood. Further, there are numerous strains of hemolytic streptococci, the beta strain being outstandingly diabolical. Beta hemolytic streptococci cause septicemia ("blood poisoning"), mastoiditis, acute tonsillitis, septic or epidemic sore throat, erysipelas (acute inflammation of the skin), scarlet fever, and several other pathological conditions. Prontosil goes into history as the first drug to be effective against these bacterial invasions. Except in the case of scarlet fever, where serums are now available, no direct treatment, not even a partially beneficial serum, was known to medicine before prontosil and sulfanilamide.

NEITHER sulfanilamide nor any related compound is "a three-day cure" for gonorrhea, which is caused by a coccus that characteristically multiplies so as to produce pairs of bacterial balls and hence is known as diplococcus. The new drugs are remarkably active here too, but weeks are always required for a cure—and a considerable percentage of the sufferers are not at all benefited by the drug. Yet the therapeutic agents have no equal in their powerful action on this coccus.

Such successful drugs as prontosil and its active fragment, sulfanilamide, stimulated feverish research among the world's pharmaceutical chemists. Hundreds of sulfanilamide derivatives have been synthesized and tested on infections in experimental animals and on human beings in the clinic. Last year, the English medical scientist, L. E. H. Whitby, published a paper describing his experiments with 64 different molecules. Of these drugs, sulfapyridine showed unique promise, as tested on infections in mice. Generally duplicating, if not surpassing, the beneficial activities of sulfanilamide, sulfapyridine in addition was proved strikingly effective against the staphylococcus, the pus coccus of boils, carbuncles, and most of the other common pus-producing bacterial invasions. Sulfanilamide is practically valueless in staphylococci invasions.

Whitby's pioneer labors have been immensely extended. Sulfapyridine, if it does not ultimately turn out to be too poisonous, is going to be used more and more against staphylococcus and may replace sulfanilamide in many treatments, perhaps in gonorrhea therapy.

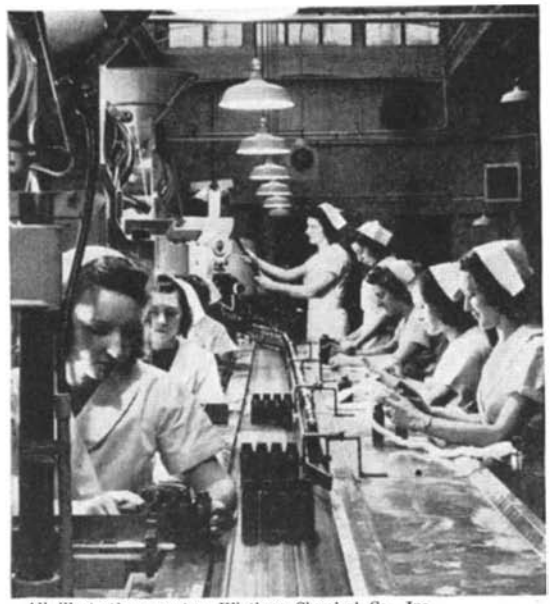
In fact, both sulfanilamide and sulfapyridine (and, of course, closely related compounds, such as prontosil) are highly toxic. Any active drug is a potential poison, because its very activity is dependent upon its power over life reactions. So toxic are these new chemical agents that the government forbids their sale without a prescription. And, as yet, sulfapyridine has not been released for general sale in drug stores, even if prescriptions were available. Use is restricted—wisely—to the leading medical experts. The experimental phase has not been passed. Great care is exercised with sulfapyridine: experience has taught that the sufferer who treats himself with sulfanilamide is liable to kill himself.

A TYPICAL view of the toxicity of sulfanilamide is that of Dr. Reuben Ottenberg, of the Mount Sinai Hospital, New York City, who sums up his study of hundreds of cases in the *New York State Journal of Medicine:* "We are dealing with a treacherous drug—one that has enormous therapeutic value and therefore cannot be abandoned, which nevertheless, on rare occasions, due to idiosyncrasies which have as yet no explanation, may develop the most destructive effects. In spite of the rapid and brilliant cures which can usually be effected, the physician should not be tempted to give the drug for minor infections. Sulfanilamide seems to be most valuable against microorganisms which are rapidly spreading, are more or less free in the tissues, or are in the general circulation."

Sulfanilamide and certainly sulfapyridine are best administered to a patient who is kept in the hospital, under close supervision. Almost daily observation is necessary, especially where the patient has not been hospitalized, and is liable to overdose himself against the advice of his doctor, or is liable to develop some sudden reaction.

Reactions are numerous and varied. "Patients who are receiving sulfanilamide therapy," advises Perrin H. Long, of Johns Hopkins, in *The Pennsylvania Medical Journal,* "should be warned against driving automobiles because the dizziness and decreased mental keenness sometimes seen in the course of therapy with the drug render many individuals dangerous on the road."

Right: **Girls filling bottles with neoprontosil tablets. Prontosil, neoprontosil, sulfanilamide (terminal syllable pronounced "mid" in spite of spelling), and sulfapyridine are all closely related compounds**



All illustrations courtesy Winthrop Chemical Co., Inc.

Below: **Filling vials with neoprontosil solution, in glass-enclosed hoods and under sterile conditions and surroundings**

Other untoward results are rashes, extreme sensitivity to light, sudden severe anemia, fever, headache, nausea, acute acidosis, loss of white blood cells, temporary insanity. But, in experienced, careful hands, sulfanilamide is not only invaluable but safe—no deaths occur, and recovery from adverse symptoms due to the drug is sure and complete. Sulfanilamide already saves thousands of lives annually. And the probability is that sulfapyridine will do likewise.

Toxic manifestations to sulfapyridine copy those caused by its chemical relatives, as is generally the case in physiology. Sulfapyridine may or may not be more toxic than sulfanilamide. Nobody knows for sure, yet—but it is beginning to seem that sulfapyridine is slightly the more dangerous of the two, though by no means excessively dangerous.

These new agents are prepared as crystals, as powder, and in solution. Administration by mouth is preferred, but injections are necessary in certain conditions, as where the patient's digestive system is upset. Sodium bicarbonate is invariably given along with the drug, because of the danger of acidosis. And, as Dr. Long and his colleagues repeat: "We cannot stress too strongly the fact that the patient who is receiving the drug needs the intelligent and careful supervision of the physician."

IT is now established that the chief factor in successful therapy is the maintenance of a certain rather high concentration of sulfanilamide or sulfapyridine in the body, over a period of days. The chemicals are extremely valuable in that they diffuse almost evenly throughout the tissues and tissue fluids, even penetrating in beneficial concentration into the most secret focus of infection, the chief spawning place of the germs. So efficacious are the new drugs, especially in gonorrhea, that recovery is often dramatically sudden—and the germs apparently disappear completely within a few days. That is why sulfanilamide has erroneously been called the "three-day cure"—and why many a seemingly cured individual may become a walking source of infection, and may himself suffer a new attack from germs not harmed but merely lurking deep within the tissues. Now, with our first wave of over-optimism subsided, we know that no cure is sure unless the case is followed through a full six-month period.

What is the explanation of the action of the new chemotherapeutic molecules? If the drug chemist knew the answer, he could discover whole systems of chemical agents, each valuable in a unique way. This mystery is for future research. A new era is before us.

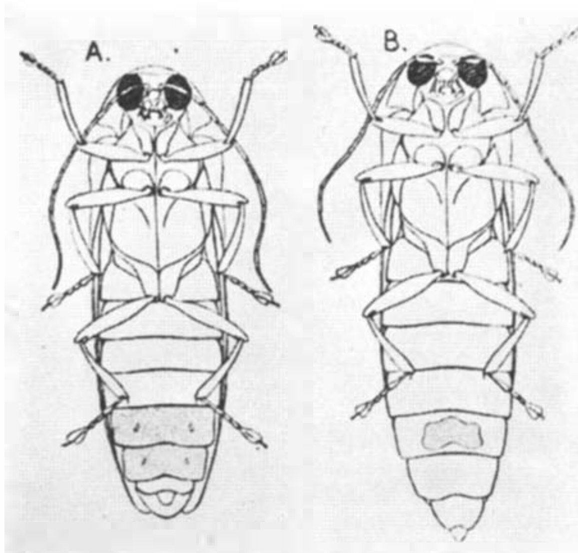
Cold Light

If Man Can Discover the Secret of the Firefly, the Effect will be Far-reaching . . . Experiments in Which Man Tries to Imitate Nature's Successes

By EVANS W. COTTMAN

FIREFLIES have long excited the curiosity of man. The first recorded attempt to make a scientific study of their light was that of Robert Boyle, who lived in the 17th Century. Boyle placed fireflies under the bell jar of his vacuum pump and gradually exhausted the air. As the air supply became thinner the glow became less intense, until finally a point was reached where it died out altogether.

In our own country, Professor E. N. Harvey, of Princeton, undoubtedly is the most outstanding of all investigators in the field of bioluminescence, or light production by animals and plants. Professor Harvey has found that the luminous material of the firefly consists of two chemical substances, which he terms "luciferin" and "luciferase." Neither of these contains any phosphorus, as is commonly supposed by many persons. They are both protein-like in nature, but their exact composition has never been determined. It seems likely that it is the luciferin which actually produces the light, while the luciferase acts as a catalyst—that is, it stimulates the light-giving reaction to take place, without undergoing any appreciable change itself. The light occurs when the luciferin comes in contact with the oxygen of the air in the presence of the luciferase. The presence of water is also necessary for light to occur. In a dried condition the luminous organs will keep indefinitely. Once the writer dried about 500 fireflies, then removed and pulverized their luminous organs. Several years later this powder, when moistened, still would glow with undiminished brightness.



Courtesy Dr. Ulric Dahlgren and the *Journal of the Franklin Institute*

Location of luminous organs on under side of firefly, shown by shaded areas. *A* is the female, *B*, male

The light-giving organs of the firefly present a marvelously complex structure. They occur on the under side of the last two segments of the abdomen. Just above these luminous cells, embedded in the body of the insect, there is a highly efficient reflector. This consists of a layer of tiny insoluble crystals, so arranged as to reflect the light downward, thus causing it to appear more intense. The luminous cells themselves contain the luciferin and luciferase, and are interspersed with countless numbers of tiny air tubes. At the time the insect flashes, air is forced temporarily into this complex network of tubes, and the oxygen reacts with the light-giving compounds, producing the light. An injured firefly will sometimes emit a continuous glow, and this is because the organs controlling the admission and expulsion of air have been impaired, allowing a constant small supply of oxygen to find its way into the tubes.

The question is often asked: Of what use is this light to the firefly? The light serves as a means for bringing the sexes together. Each sex and each species has its own characteristic light and its own methods of flashing. Some have a yellowish flash, while others have a bluish green. Likewise, some flashes are long and deliberate, while others are quick and nervous. Professor Ulric Dahlgren, of Princeton University, some years ago devised a tiny electric flashlight with which he was able to imitate the color and style of flashing of various types of fireflies, and with this he was repeatedly able to attract large numbers of male fireflies by imitating the female's flash.

The eggs of the firefly are laid in late spring or early summer, around the roots of grasses in damp, moldy places. At the end of about 22 days, the luminous organs begin to develop within the eggs and the eggs begin to glow. These hatch in midsummer into tiny luminous grubs, the glowworms. The glowworm is the larva of the firefly, just as the caterpillar is the larva of the butterfly. (The name is also applied to the adult wingless females of some species.) Glowworms hide during the day, but emerge at night to seek food, their diet consisting chiefly of snails, slugs, cutworms and small earthworms. For two summers they eat and grow, but hibernate during the winter. The third spring they emerge again and shortly afterward pass into the pupa stage. Inside the shell of the pupa case wings develop and the light-giving organs change into the adult form. At the end of about 17 days the adult firefly emerges. Shortly afterward it mates, the eggs are deposited and, after a brief life on the wing, the insect dies. The glowworm can easily be distinguished from the firefly at night by its continuous glow, whereas the firefly emits its light only in flashes. Also, the glowworm does not fly. In the glowworm the entire area of the segments of the abdomen do not give off light, the luminous areas being limited to tiny spots.

Interesting as our own fireflies are, others in foreign lands are more spectacular. In South America there is a species called locally the automobile bug because it has a white light in front and a red one behind. In New Zealand there is a large underground cavern, its walls and ceiling frequently covered with millions of glowworms. The interior of the cavern is well illuminated by them. The Sumatra glowworm is famed for its brilliance. It possesses 38 spots of light. One species of beetle in South America gives such a brilliant light, that it is sometimes collected by the natives for illuminating their homes.

Besides fireflies, numerous other animals and some plants give off light. Any one living near the ocean has probably at some time noticed a dead fish, in the early stages of decay, emitting a greenish light after dark. This is caused by a certain type of marine bacteria. A story is told of a butcher whose shop acquired the reputation of being haunted. The meats had become infected with luminous bacteria and glowed at night. These bacteria can be artificially grown in a suitable liquid culture medium. They emit a constant steady light which attains its maximum in about two days. This light serves the bacteria in no way known to man, if at all, and seems to be merely incidental.

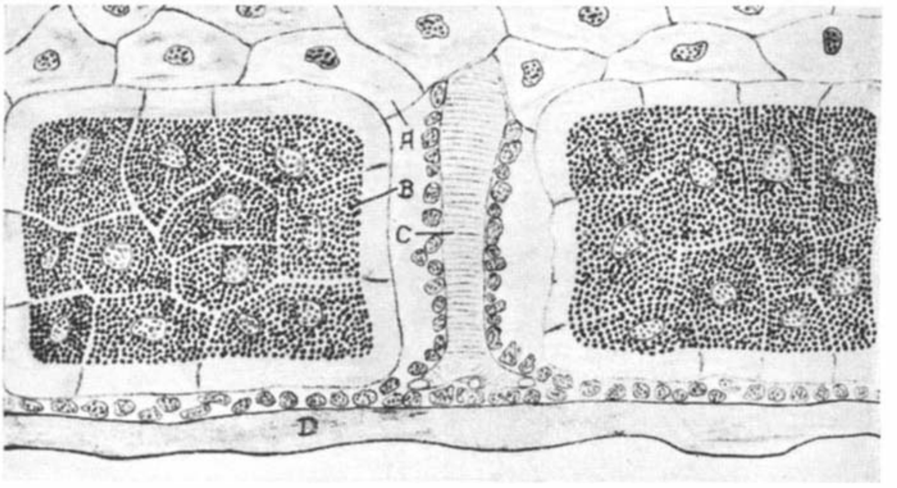
Bacteria cannot be stimulated into emitting light by mechanical shock, electric shock, or heat. A slightly alkaline condition is more favorable for light production and no light is ever present in an acid medium. Bacteria have been concentrated into a small space by centrifuging —whirling them about at a high rate of speed. Such concentrated suspensions of luminous bacteria glow with greatly increased brilliance, emitting sufficient light to enable one to read print at a distance of several feet from the light.

Human perspiration and the urine of animals have been observed on rare occasions to glow in the dark. Generally this has been ascribed to the presence of bacteria accidentally taken into the stomach on food. While this may be the case, the writer has found that various excretory products are themselves luminous when properly oxidized.

Many mushrooms and other fungi contain substances which glow when exposed to air. Especially is this true of the mycelium, or network of fine threadlike tissue, from which the mushroom grows. This mycelium permeates the decayed wood from which they may appear and, if the wood be torn apart, the fibers of the mycelium are broken, exposing their contents to the air. This causes the glow called fox-fire, which often has been observed on damp, rotten wood.

In many localities the sea contains myriads of Noctiluca, little one-celled animals which will emit light when disturbed. A boat passing through such water leaves a wake of golden light, due to the disturbance of these organisms. The sands near the shore are left saturated, when the tide goes out, with water containing these tiny living forms. Treading upon these sands disturbs them, and thus footprints of golden light are left impressed upon the sand.

The luminous deep-sea fishes have long been a source of interest and wonder and many articles have been written on them alone. Some have rows of luminous spots running along their sides, giving them the appearance of miniature ocean liners at night. Perhaps the most interesting is the deep sea angler. This fish has a long stalk extending out from its head. On the end of the stalk there is a "light bulb," surrounded by little appendages which look like worms. This luminous device hangs just in front of the fish's mouth. The light and the "worms" attract smaller fishes, which of course places them in



A highly magnified section through the luminous organs of a firefly. *A* represents cells of the reflecting layer. *B*, luminous cells, the little dots being granules of luciferin. *C*, air tube admitting oxygen to luminous cells. *D*, transparent skin over the lower surface of the luminous segments of the abdomen. The light produced in the cells *B* is reflected out through *D* by cells *A*, as is described in the text

the most convenient position for the large fish to swallow them.

Among other luminous forms of animal life are numerous kinds of jellyfish, sponges, marine worms, earthworms, centipedes, brittle stars, mollusks, shrimps, crabs, cuttlefish and squids, the total number of species running into many thousands. One species of squid has luminous organs on the ends of its tentacles. It flashes these like a firefly. One of the most brilliant of all luminous animals is Cypridina, a small marine ostracod crustacean. In this animal the luciferin and luciferase are discharged into the surrounding water, producing a brilliant blue luminescence. Dr. Harvey used this animal extensively in his researches.

SINCE nature has supplied cold light in so many forms, it is natural that man's interest should be stimulated, and that he should try to imitate her. In 1877 the chemist, Radziszewski, prepared lophine and discovered its luminescent properties when oxidized. Lophine gives a beautiful yellow light. Directions for its preparation and treatment have been stated in Scientific American [August, 1937, page 120.—*Ed.*]. The writer has prepared about a dozen derivatives of lophine, most of which have been luminescent.

An orange-red luminescence can be produced by treating pyrogallol (commonly used in photography) with formaldehyde and hydrogen peroxide in strong alkaline solution. Dr. Harvey produced light by oxidizing pyrogallol with peroxide and potato juice.

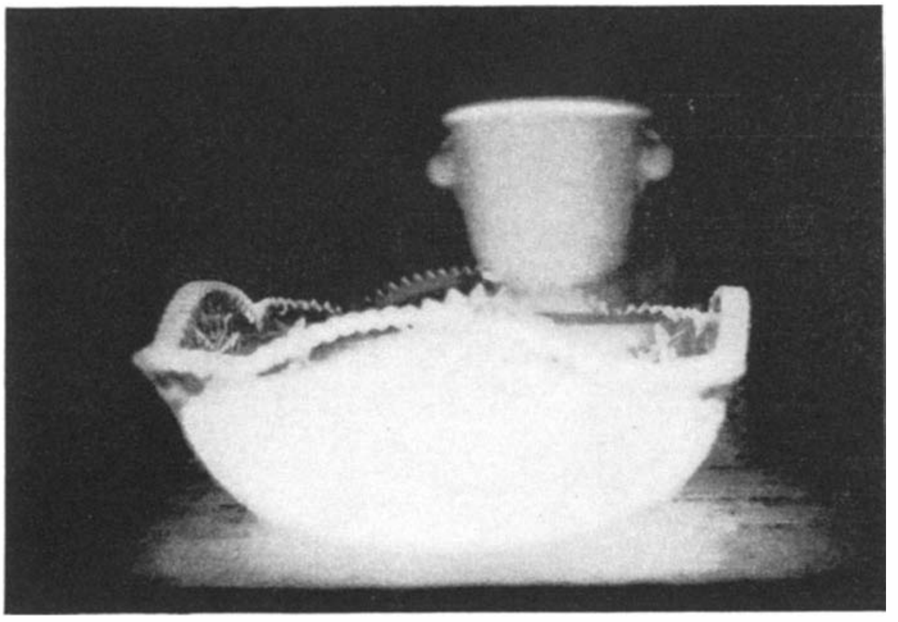
In 1923 W. V. Evans and R. T. Dufford described a series of luminescent compounds which they had prepared. These belong to the class known chemically as Grignard compounds, and one of them, p-chlorphenylmagnesium bromide, gave the brightest chemi-luminescence that had yet been produced.

In 1929 the German chemist, Albrecht, discovered a chemical which, when oxidized, gave forth the most intense and brilliant cold light thus far known. This chemical has received considerable attention in this country, and much research work has been done on it by Dr. E. H. Huntress of the Massachusetts Institute of Technology. The chemical name of this compound is 3-aminophthalhydrazide. For convenience Dr. Huntress has proposed the term "luminol." Upon oxidation it produces a brilliant blue cold light which makes a striking display when demonstrated before an audience.

The writer has developed a luminol preparation in a dry powder form termed "chemglo." As this powder contains the correct oxidizing agents, it is necessary only to add it to water in order to produce luminescence. An accompanying photograph was taken by chemglo cold light.

One would hardly expect to get light out of sugar, starch, and such compounds, but that is what I am doing in my laboratory. This type of compound does not itself give visible light upon oxidation, but does so if heated or fused first, and then oxidized. The following compounds have been subjected to this treatment with positive results: cane sugar, glucose, levulose (fruit sugar), lactose (milk sugar), galactose, starch, dextrin, gum arabic, tartaric, lactic, malic and citric acids. The citric acid seems to offer exceptional possibilities, as the flash from it is unusually brilliant.

The cold light described thus far belongs to the class known as chemi-luminescence. It is in every case caused by chemical action—the oxidation of some chemical compound, usually organic. There are, however, many other types of cold light, some of which have been studied much more than chemi-luminescence. When an electrical discharge is sent through a vacuum tube containing traces of various gases, a brilliant cold



A photograph taken by light produced by a luminescent chemical in solution in the nearer vessel illuminating the other. Kodak Bantam Special, 10 min., $f/2$

electro-luminescence may occur. Radio-luminescence, derived from radium, is used on the dials of "radium" watches and clocks. Crystallo-luminescence is the emission of light when certain substances crystallize from solution. Tribo-luminescence is the production of light when some kinds of crystals are mechanically crushed. Bio-luminescence is applied to the light given off by animals and plants; it is a kind of chemi-luminescence.

FLUORESCENCE occurs when light of one wavelength or color is changed and emitted as another color. Fluorescent substances may appear brilliantly colored in the dark when exposed to ultra-violet rays, the so-called black light. These colors immediately disappear from a fluorescent substance when the black light is turned off, but if the light persists for a time after the ultra-violet rays are removed, the phenomenon is called phosphorescence. A phosphorescent mineral may glow for several hours after having been exposed to sunlight. The term was originally derived by suggestion from the element phosphorus, which glows in the dark. However, in the present sense, it is a misnomer, as phosphorescent substances have nothing to do with phosphorus. It was formerly thought that fox-fire, and all lights produced by animals and plants, were in some way connected with phosphorus. This has been found untrue, and the term luminescence is used in place of phosphorescence for describing this phenomenon.

One of the most surprising discoveries in the realm of cold light has been made by Dr. Leslie A. Chambers, of the Johnson Foundation for Medical Physics in the University of Pennsylvania. He has produced visible light by means of sound waves. He places a powerful vibrator in a liquid and causes it to vibrate at a high frequency. When this is done many liquids emit light. He reports that viscous liquids at a temperature of about 77 degrees, Fahrenheit, are most favorable for this type of luminescence, which he has termed acoustico-luminescence. He produced his brightest light from glycerin, which is very viscous.

The first question asked by the practical reader after all these considerations will be: "What use can be made of cold light?" At present we must admit frankly that we do not know. The study of this subject is in its infancy; the phenomenon is, as yet, regarded as a laboratory curiosity. Yet, practical-minded scientists are continually lifting just such laboratory curiosities out of the realm of pure science and finding applications for them. It is certain that Oersted could never have dreamed of electric motors, telegraphs, and our long list of electromagnetic appliances when he was making his first interesting studies of the relation of magnetism to electricity.

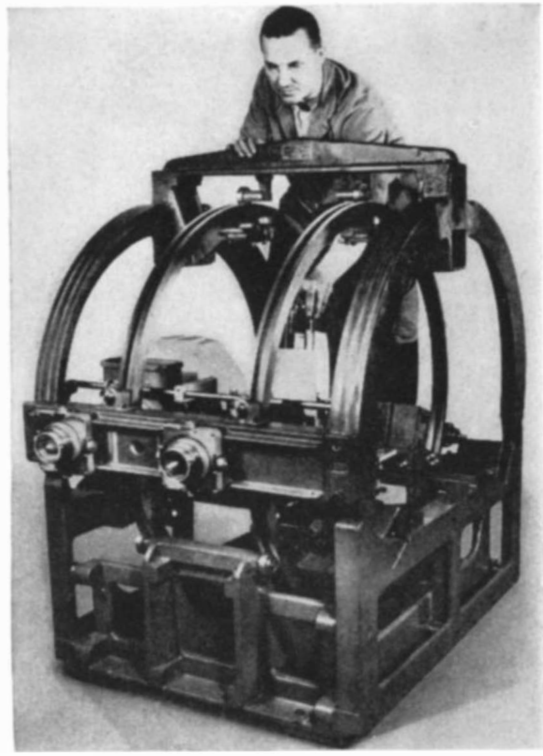
Cold light seems to have certain theoretical possibilities. It is the most efficient light known. Most lights expend from 95 to 98 percent of their energy in the form of useless heat. Cold light, on the other hand, expends from 90 to 98 percent of its energy in the form of pure visible light. There is scarcely any perceptible heat loss. The intensity of the light, however, is so small that it would require a large light-emitting surface to illuminate a room thoroughly. The present costs of materials would make such a method of illumination impracticable. It will first be necessary to discover brighter and cheaper cold light chemicals.

Occasionally in newspaper articles the claim is made that the secret of the firefly has been discovered. Such articles usually have reference to luminol. This is, indeed, a brilliant cold light preparation, but is far from being the answer to the firefly's riddle. If the secret of the firefly were really to be discovered, the effect would probably be far-reaching. The firefly is one of the most efficient organisms in the world. Not only is its light efficient from the standpoint of visibility, but in economy of fuel consumption it is even more remarkable. When the insect flashes, its luminous material is oxidized, giving off light. During the time that the organs are dark, a reversal of this process takes place, and the products of the oxidation are reduced back to their original condition, ready to use over again. It is much as if one could burn a log, then catch the smoke, gases and ashes, and put them together to remake the log.

Possibly cold light will prove to have more uses in the field of medicine than in illumination. I have obtained light by the oxidation of urine and a number of the isolated products of metabolism. Also I have frequently used blood to oxidize such compounds as lophine and luminol. A very good light can be produced from the oxidation of urine by blood, in alkaline peroxide solution. In the laboratories of the Eli Lilly Company I obtained measured amounts of blood from an anemic guinea pig, likewise from one which had been rendered normal by giving it liver extract. The two samples of blood were used to oxidize lophine. A very perceptible difference could be observed in the amount of light, the latter sample being the brighter. While little has been done in this direction, it seems quite possible that a technique might be developed for using such phenomena as an index to certain physiological conditions. If these physiological lights could be amplified and made the subject of intense spectroscopic study, the horizon of possible applications would be immeasurably extended.

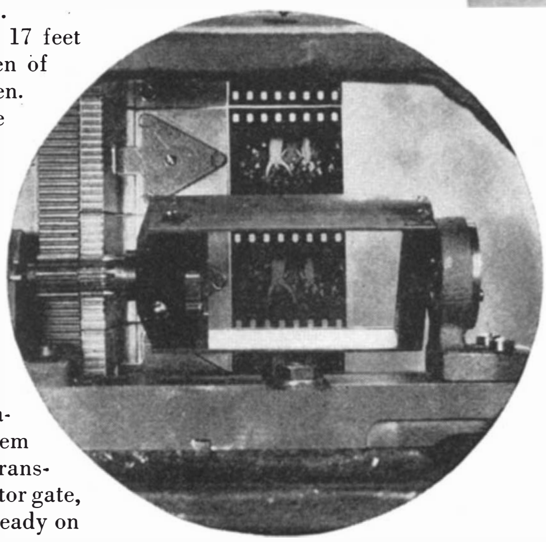
DR. GEORGE CRILE, of Cleveland, has made some investigations in the field of physiological radiations. He has caused animal brain tissues, reacting to chemicals and gland secretions, to give off visible light. Dr. Crile feels that the luminescence affords experimental evidence that the brains of animals and man may produce their own light, and "that the sun shines again in the protoplasm of animals." He believes that consciousness and such mental processes as thinking may somehow be connected with these mysterious emanations from the brain's supremely delicate tissues. It seems quite certain that all the materials necessary for luminescence are present in the human body. Normally, these are not brought together, but if this were to occur abnormally, it might explain the occasional luminosity reported as occurring in certain rare individuals—a woman in Italy, for example.

Color on a Huge Screen

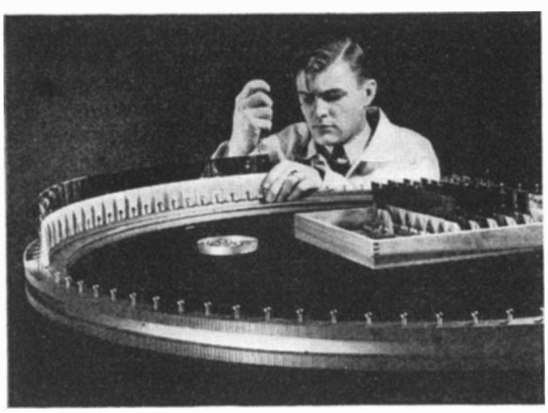


IN a continuous flow of glowing color, single scenes or groups of scenes fill the 187-foot long screen that is part of the Eastman Kodak Company's exhibit at the New York World's Fair. This gigantic display of modern color photography is made possible by new twin projectors, 11 of which are concealed in a projection booth just under the roof of the hall. Through each of their gates stabs a brilliant beam of light. Tiny color-film transparencies, about 1 by 1½ inches, made on standard Kodachrome film, pass these gates—to become full-color screen pictures approximately 50,000 times larger than the originals.

Each of the screen pictures is 17 feet wide and 22 feet tall, and eleven of them exactly fill the 187-foot screen. It is interesting to note that the transparencies which produce these enormous pictures were made with cameras similar to those used by many amateur photographers.



As each small transparency comes into position, it is registered in place to an accuracy of plus or minus 1/10,000 of an inch, through a combination of optical and mechanical registration. This same registering system operates so that even while the transparency is in motion in the projector gate, its enlarged image is held rock-steady on the screen—no motion can be detected.



Top, right: One of the twin projectors, partly assembled. Behind the lens at the left is shown one of the lamp houses and heat filter. _In circle:_ The rectangular piece of optical glass that registers the film transparencies exactly. In this view, the film slide is slightly high in the gate; the registering plate is automatically tilted to provide correction. _Left:_ Bolting the slides on the "drum" gear

Each of the hidden projectors is synchronized with the others by an electrical interlock—operating through a fully-automatic control system. Through its electrical interlock and control mechanism, the projection system can be operated with infinite flexibility. If desired, pictures can be changed at different speeds—one group of pictures remaining on the screen a half-minute while others are changed up to four times a second. Fades, dissolves, motion effects can also be presented.

The "heart" of the projection system control is a specially notched sound-film, which not only carries the voice of a commentator and special musical accompaniment, but also regulates the movement of the projector shutters and the shifting of slides—keeping pictures and comment in perfect synchronism.

Employed in the projectors are large fine-pitch precision ring spur gears, each one 45 inches in diameter and carrying 1440 teeth. On these "drum" gears are bolted glass-mounted color transparencies—96 pictures to a drum. Twenty-two gears are used in the 11 twin projectors, so that the system carries 2112 color-film pictures ready for automatic projection.

To link the gear-rings with the automatic indexing system, the projectors employ one of the largest single-step spur gear reductions ever attempted—48 to 1. The 45-inch gears work directly from a 15/16-inch pinion.

EACH color slide carries a series of gear teeth, integrally mounted along its edge. Together, these teeth form a continuous series around the film ring, and serve to operate the optical registering system built into each film gate. This registering means consists of a small rectangular plate of optical glass, which spins as the film ring rotates. As each picture moves into position, this glass swings upright before it. If the picture halts a trifle too high in the gate, the registering-glass remains tilted slightly forward at the top. If the picture stops too low in the gate, the glass tilts back correspondingly, its movement being controlled by the gear teeth on the film. In either case, refraction through the glass shifts the picture-image so that it travels at proper level through the lens, and is correctly positioned on the screen.

The illuminating system of each projector is centrally housed, with the ring gears and film drums revolving around it. Water cells are used for cooling, and in addition, a blast of air, chilled almost to the freezing point, is directed on each projector gate. Large-aperture, long focus projection lenses are used, and specially designed shutters are utilized for many screen effects.

What Keeps the Stars Shining?

For the Source of Stellar Energy We Must Look To Reactions Between Charged Atomic Nuclei . . . Discussions and Background for Bethe's Theory

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

WE told last month how it can be shown, from the general properties of matter, that a large mass, isolated in space, must be gaseous and very hot inside—millions of degrees; how the heat must escape slowly to the surface, and keep this incandescent; and how the observed relation between the mass and the real brightness of a star has thus been fully explained. But the great question why the stars keep on shining remained.

Helmholtz and Kelvin were undoubtedly right in saying that such a gaseous mass, if not otherwise supplied with energy, would slowly contract, drawing on gravitational energy, converting it into heat, storing half this heat or more in its interior, and using the rest to maintain its radiation. But the Sun has been warming the Earth during the whole of geological time—that is for more than 1500 million years, and in this long interval it must have got rid of a hundred times more energy than gravitational contraction could supply. The Sun, and the stars in general, must therefore have some internal source of energy far greater than this.

This would have been perplexing indeed, had not the very same physical discoveries which revealed the problem pointed a way to its possible solution. It was from radio-activity that the evidence came which showed conclusively that individual crystals of minerals had lain in the rocks for more than a billion years since their formation; and it was radioactivity, too, which revealed the existence of vast and previously unimagined stores of energy locked up within atoms.

To the minute atomic nuclei, therefore, we had to look as the only places small enough to hold so much. (This is not a paradox, but a way of describing the enormous magnitude of the forces which act at these minute distances.) The obvious suggestion that there were radioactive substances inside the stars, which liberated the heat necessary to keep them going, might account for a life of billions of years; but, unfortunately, when it was followed up, it didn't work.

To begin with, radio-active atoms liberate energy at a rate which is quite independent of external conditions—temperature, pressure, and the like. By assuming the presence of a certain calculable amount of uranium (for example) in the Sun, we can account for the maintenance of its radiation—though the percentage of the whole mass came out rather high. But the more massive stars are much brighter, and radiate much more energy in proportion to their masses. To match this by radio-activity, we would have to assume that the amount of active material had been, in some strange way, so adjusted that the massive stars contained a larger percentage, and those of small mass a smaller, exactly adjusted to meet their needs. It is not necessary to assume (as one would think) that the stars were purposefully made in this way. A star with too little active material to supply its inevitable losses would draw on gravitation for the rest, and shrink; one with too much would be forced to reverse the history imagined by Kelvin, and expand. If the Universe is old enough, the under-supplied stars might have shrunk out of sight, and the over-supplied expanded into nebulosity, leaving only the well-balanced ones to be counted. But this is hard to believe.

WE do not have to try, anyhow, for another objection to the radio-active theory turns out to be fatal.

A more detailed calculation of the theoretical luminosity of a star shows that, for a given mass, it increases slowly with diminishing size. Suppose, then, that there was a perfectly adjusted star, of given mass and radius, and that, in any way, it became a little smaller. It would then be a little brighter, and lose more energy. But the radio-active supply would be just the same. It would draw on gravitation for the balance, contract, and get more out of adjustment than before. Things would rapidly get worse, and the star would contract "out of sight." If, on the contrary, it should be slightly expanded above the ideal size it would be supplied with radio-active energy faster than it got rid of heat, would be forced to expand further, and again would run wild. A star supplied by an atomic energy source *at a fixed rate* would therefore be inherently unstable. The process of "running wild" might take a million years (more or less) to get well going, but would be inevitable.

We can get away from this trouble by assuming that the otherwise unknown atomic—or sub-atomic—process depends in some way upon collisions between atoms, and not on happenings in the interior of an isolated atom (as radioactivity appears to do). We should then expect its rate of occurrence, among the same number of atoms, to increase with the density, since the atoms would collide oftener, and especially with the temperature, since the collisions would be more violent.

Now suppose that we had a star out of adjustment, with the atomic process supplying too little energy. It would draw on gravity for the rest, and would contract. This would make the gaseous interior denser, and, as we saw last month, also raise its temperature. The atomic process would then supply more heat. If (as is very probable) this gain in income exceeded the (rather moderate) gain in outgo from the surface which accompanied the contraction, the star would be nearer a balanced budget after the contraction than before. There would be a certain size of the star at which income and outgo were equal. This would give a state of equilibrium, and, this time, the state would be stable. Suppose that the contraction overshot the mark. Too much heat would then be liberated; but this would force the star to expand, make the interior less dense and cooler, and *shut off the over-supply*. A star fed by an atomic source at a rate increasing with temperature and density would therefore be self-regulating; it would automatically seek and find a balanced state, in which just enough heat was liberated to supply the natural flow to the surface.

One further complication has to be considered. Suppose that we started with a star that was not quite in mechanical equilibrium—say a little too large, so that the internal gas-pressure did not balance gravity. It would contract, overrun the neutral point, as such things always do, get too small, be impelled to expand, and so find itself in a state of oscillation or pulsation, changing in diameter with a regular period. Eddington showed, years ago, that the flow of heat from the hotter to the colder parts of the gas would have a "damping" effect on such an oscillation, gradually reducing its range to nothing—as the friction of the air does to a pendulum.

But, if the heat-supply increases rapidly with temperature, most of it will be liberated when the pulsating star is smallest. This is equivalent to giving the outward motion afterward a little push at every oscillation, which tends to increase the range. If the damping effect predominates, the star, if disturbed, will settle down into quiescence; but, if not, a pulsation once started will increase—probably not enough to break up the star, as it is likely to be limited in extent by additional influences. Many stars are known—the Cepheid and cluster variables—which appear to be doing just this; but the vast majority of the stars are steady-going affairs of fixed diameter. Hence our theoretical source of energy-supply must not increase too violently with the temperature.

At one time this appeared to be a troublesome limitation. But, a few years ago, Cowling showed that, if the rate of heat-production increased rapidly with the temperature, there would be a convective region, near the center of a star, where currents of heated gas would be rising and cooler gas from farther out descending to take its place. He concluded that, under these conditions, the instability which leads to large pulsations would not occur unless the rate of energy-liberation increased faster than the 20th power of the temperature—which affords a pretty good margin.

So much we can learn from the stars themselves—about the properties which the energy-liberating process must have, if it is to satisfy the astronomical conditions.

WHAT processes of this sort could occur in Nature we must assume, if we can, by appeal to physics—and physics of a very modern sort.

Our first aid comes from relativity—the general relativity which is Einstein's greatest achievement. According to this, mass and energy—previously supposed to be each separately "conserved" and indestructible—are convertible one into the other, at such a rate that m units of mass (grams) are equivalent to mc^2 units of energy (ergs)—where c is the velocity of light.

Theoretically, then, the mass of a body should be increased by heating it, and so adding energy to it. The reason why this cannot ordinarily be measured is that c^2 is an enormous number (9×10^{20}), so that a very large amount of energy, measured by everyday standards, corresponds to an excessively small mass. For example, a ton of iron cooling from its melting point to ordinary temperatures liberates heat equivalent to 150 kilowatt-hours of energy; its mass is diminished by 1/160 of a milligram!

When we come to astronomical figures, we find that the Sun radiates into space 3.78×10^{33} ergs per second. To say that this rate is equivalent to 5×10^{23} horsepower conveys no real significance to us, whether we write out the 23 ciphers or not; but when we divide by c^2 we find that the Sun is sending out 4,200,000 *tons* (metric) of heat into space every second, or 1300 millions of millions of tons every year. At first glance this looks a little alarming. How long would it be before the Sun was used up, at this rate? We need not worry, the Sun's mass is 1.98×10^{33} grams, and it would last 1.5×10^{13} years—15,000 billion.

For the source of stellar energy, then, we must look to some process which changes the mass of atoms, and liberates a corresponding amount of energy. When this was first realized, more than a decade ago, we had a free choice between two hypotheses—because there was no experimental evidence at all on the subject. One was that, in some way, atoms were annihilated, while all the energy corresponding to their mass was set free; the other, that atoms of one kind changed into another, with a net diminution of the total mass, and liberation of energy. At the present time, we have pretty well stopped playing around with the first idea, for the good reason that it remains purely speculative, without any direct evidence in its favor (so far, at least, as regards ordinary atoms). The second notion has meanwhile advanced from the status of a hypothesis to that of an established fact. With the aid of the natural projectiles emitted by radio-active substances, and the artificial ones accelerated in cyclotrons and similar devices, an amazing variety of nuclear reactions has been produced in the laboratory. Dozens of new kinds of artificial atoms have been made—some of them in several ways—by breaking down or building up from familiar ones. Atomic masses have been measured with great precision by the mass-spectrograph; the energy liberated in the reactions has also been measured; and by comparing the loss of mass with the liberation of energy it has actually been possible to calculate the velocity of light from Einstein's formula. The result is of no great percentage accuracy, but it fully justifies the claim that the equivalence of mass and energy is now a fact proved by experiment.

All these reactions occur between the tiny nuclei of the atoms; on their scale, the outer electrons are merely distant satellites, remote from the colliding particles, and not directly affected by what happens to them. They fall into two general classes—encounters between charged atomic nuclei and neutrons, and between two charged nuclei.

Most of the reactions which have been produced in the laboratory are of the former type—for the simple reason that the atomic nucleus and the neutron neither attract nor repel one another (except at very small distances, indeed), so that a neutron which happens to be moving almost directly toward a nucleus stands a fair chance of getting near enough to it to do something, even if the nucleus is heavy, and has a large charge. But two nuclei, being both positively charged, repel one another. Even a hydrogen nucleus (proton) with its single unit of charge, is so powerfully repelled that, unless its original line of motion was directed almost absolutely straight at the nucleus, it would be deflected to one side, and would miss it. Even if it were correctly aimed, it would be slowed up by the repulsion, stopped, and sent back along the same path, without getting near enough to do any damage, unless its initial speed was very high.

THE very thing, however, which makes neutron-reactions the delight of the laboratory physicist makes them unimportant for the astrophysical theorist. Such reactions happen so easily that, in the interior of a star, a free neutron would not remain free for a thousandth of a second—long ere this, it would have hit some atomic nucleus, gone into it, and either built it up into a heavier one or broken it into pieces. If any of the pieces were fresh neutrons, the process could go on repeatedly—and perhaps explosively; but, so far as present observation goes, this does not happen. The neutron is used up in the reaction, and only charged particles come out of it.

Hence, if there were any number of neutrons in the Sun now, there would be practically none a thousandth of a second afterward. We could invoke them, and the reactions in which they take part, as permanent sources of energy only if "new" neutrons were continually being produced, inside a star, by some sort of reaction between charged nuclei. To anticipate a bit, it may be said here that the possibilities of such processes have been exhaustively explored by experts, only to find that they would occur, if at all, so very rarely as to have no practical effect.

For the source of stellar energy, we must therefore look to reactions between charged atomic nuclei. Here a notably successful theory has been developed by Professor Bethe of Cornell, along lines resulting from the recent work of Gamow and others, and the pioneer theory which Atkinson suggested several years ago, before neutrons had been discovered and while nuclear physics was still too young to permit us to follow out the various processes in detail. But again space fails, and our story must be "continued in our next."—*Princeton University Observatory, April 5, 1939.*

They Never Say 'No'

"Prop" Men Furnish the Thousands of Odd Items That Make Motion Pictures More Realistic

By ANDREW R. BOONE

"MEMO to prop department: On Stage Four, nine o'clock Thursday morning, one Statue of Liberty, carved out of ice; double for Charlie McCarthy; mouse complete with hole; one blue snake dressed like a cobra; dummy camera; 100 rubber arrows."

Irving Sindler, veteran Hollywood property wizard, read the order, whistled softly and set to work. Instructions sped to assistants, but he took over the most exacting job himself. Bending alone over a huge cake of ice in a Los Angeles cold storage plant, he worked through the night and next morning at sunup packed the little statue in heavy burlap bags, surrounded them with dry ice and drove across the city to the studio. When the principals were ready for the scene in "The Cowboy and the Lady," Sindler set the statue on a base of mashed potatoes, which doubled for ice cream, and placed it in front of the camera.

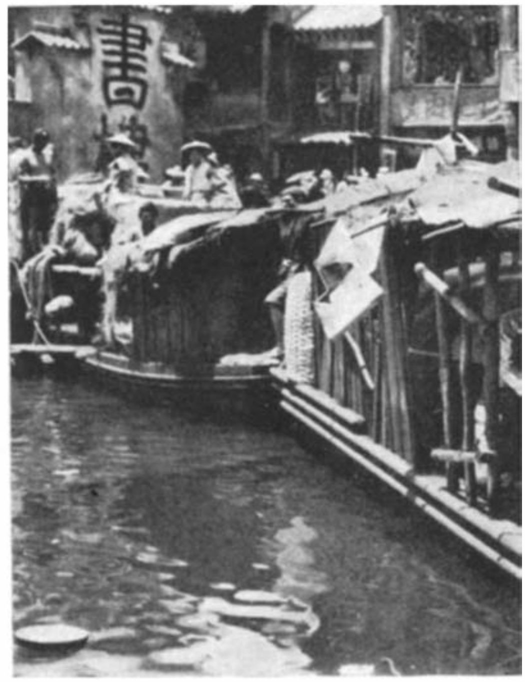
Sindler is one of those unknown wizards of the screen, the property men who must have within reach every manner of thing, from crooked dice to synthetic blood, or be able to find or make overnight whatever the director demands, no matter how outlandish it may be or difficult to produce. Items numbering in the thousands are constantly required.

Hollywood's property creators never know what contraptions may be demanded next. Early one Sunday, a director decided he must have a "prop" mocking bird for several closeup scenes. Not only did he order it delivered Monday morning, but the little bird must be able to move its head and beak as though in song, flap its wings, flirt its tail and ruffle the feathers on the neck. One day for the job! Yet 24 hours later a synthetic mocking bird stared back at the camera, its life-like movements created by invisible piano wires running up through the body to the various parts.

In modern motion pictures, the property man has become an integral part of the production. He is responsible for all the furniture, furnishings, and things used or carried by players. If a gentleman pulls a handkerchief from his pocket for a specified piece of business, that handkerchief becomes a "prop," and no longer is part of his wardrobe. A property man refolds it.

Were you to visit the property department of any major studio, you would find the most amazing collection of "things" ever brought together. Cigar store Indians rub elbows with a replica of the Grand Llama of Tibet. Machine guns which once fired across No Man's Land in the World War, revolvers made of rubber, crooked dice, and "fixed" roulette wheels. Everything ever used once in a picture.

Many other things are not what they seem in the movies. Fruits and vegetables for instance; dinner ware, glasses, pictures on walls, and windows. Not only must the property man keep ample supplies on hand for eating sequences; it's up to him to preserve them through long, hot days under the brilliant lights. He shellacs lettuce to keep it fresh and stiff; sprays fruit to discourage flies; changes the water on cut flowers every two hours.



Above: **Property men scoured Los Angeles' and San Francisco's Chinatowns for utensils and decorations seen in these Chinese junks, which floated on an artificial lake**

THESE jacks-of-all-trades also assist the camera man by killing highlights. Instant-drying liquid wax and putty kill reflections from glass-covered pictures. And between scenes involving glass doors or windows, the property man pastes long strips of black paper on the glass, to warn roving actors and technicians against walking into trouble.

Should you look over the shoulder of a property man into his case of props, you'd find an amazing collection of knickknacks. Labels, theater tickets, business cards, bank checks from all countries, ink, manicuring scissors, harmonicas, candy, slugs to serve as money, blood (glycerine and carmine powder), knee pads for falls, fuller's earth to make dust, airline and railroad tickets, candles, and needles are only part of the long list.

Most unusual, perhaps, of all demands on the property men was an order for an acre of cogon grass weed with which to dress a tropical scene for "The Last Frontier." None was available in the United States, and the U. S. Department of Agriculture refused permission to import the plant. An ingenious handler of props solved the problem by securing permission to have five pounds of seed flown in from the Philippine Islands by Clipper plane, on the strength of his guarantee to keep the pernicious weeds cut before they came to seed. And he had to destroy the plants by burning when the picture was completed.

Below: **On one large outdoor set, 28 large palm trees were included in the property order. One of the trees is shown here being carried to location by a small hoist**

Left: A dummy camera, a sponge rubber microphone, and part of an order for one hundred rubber tipped arrows. All were turned out in a week by one property man

Right: Final adjustments being made on a machine gun just prior to a movie battle. The property department can supply any type of gun at a moment's notice

Right: A portable cabinet. Hundreds of items must be furnished by the property department for each picture

A miniature Statue of Liberty was carved in ice for a dinner party scene in a recent picture. Wooden "stand-in" is at right

Below: Irving Sindler painting celery with shellac to preserve it under the lights of the movie set. Parts of fruits and vegetables to be eaten are carefully marked. Those sections are left untreated, so the shellac will not be eaten

Below: Often for larger pictures, property men rehearse their jobs with models. The models may or may not be used in the actual filming

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

Food in a Balloon

THE latest transparent food wrap is rubber, and it has fulfilled its principal purpose long before it reaches the retailers' shelves, with its sales appeal "purely coincidental," according to the *Industrial Bulletin* of Arthur D. Little, Inc.

The name Cryovac will be recognizable to our classical race of food venders as possibly meaning "cold and empty." Such an unorthodox trade name is descriptive of the history of the new wrap before it is put on sale. In its original form it resembles a deflated, wide-mouthed toy balloon. It is blown up, however, by stretching the wide mouth over a frame and drawing a vacuum around the outside. It thus takes the shape of the cylindrical container into which it has been drawn—and the chilled sides of the container "freeze" it into the larger size. Into such an open-end package is dropped a broiler; a vacuum hose removes the inside air and draws the wrap close to the contents; then the neck of the balloon is twisted and clamped to make the whole vacuum pack air-tight. Then comes the trick—the package is immersed in warm water to "thaw" the balloon; it attempts to shrink to its original size, and stretches to a taut, transparent wrap around the plump chicken.

Vacuum packing—in a balloon

Various potential advantages for such a food container are obvious, and Dewey and Almy claim to have realized many of them without most of the possible objections. A special latex rubber was necessary, with no sulfur. Special equipment was designed to reduce the handling time in packaging to a point well below that for many other wraps. Formulas and production technique developed in the manufacture of latex sounding balloons were required for the necessary low cost, strength, and so forth. Incidentally, in the chilled, expanded form, the rubber has surprisingly great strength. Most of the advantages claimed are due to the elimination of air or to the complete moisture tightness. Pork products, for example, are said not to develop rancidity in the fat, chickens to show no "freezer burn," the bane of low-temperature preservation of poultry. Prevention of moisture loss not only preserves the original weight, but reduces frosting of cooling coils in the refrigerating units, and increases their freezing efficiency.

Bags for poultry are designed as one-trip containers to be removed by the consumer. Larger bags are intended for the storage of seasonal surpluses of green hams, pork loins, and the like, which are temporarily frozen and released for the market as needed. For these purposes, the latex bags can be washed, shrunk, and reused several times. The largest bags are being designed for use with quarters of beef, veal, and lamb carcasses, and are expected to find their principal market in the export field. A bag for a 350-pound side of beef is said to be a practical possibility.

Rubber Lubricant

GLYCERINE has been proved to be superior to mineral oil lubricants for rubber tubes and other rubber articles for surgical use by a long series of severe tests. Comparison between mineral oil and glycerine was made by coating tubes with each of these fluids, washing with soap solution after five minutes, rinsing with water and finally boiling five minutes to sterilize them. Rubber tubes lubricated with oil were unfit for use after 37 such cycles. After 200 boilings, those lubricated with glycerine were still firm and usable. The lubricating action of each is satisfactory.—*D. H. K.*

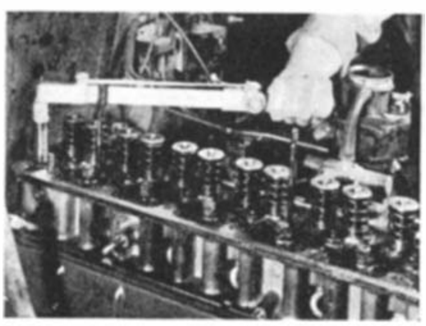
Pilot Valve

A NEW industrial development by A. Schrader's Son, known as the Pilot Valve, is designed to give a delayed or prolonged blast of air for ejecting work from a press, after the ram has stopped its upward motion. It is especially useful on manually fed presses using over-head knockout or compound dies.

The duration of the air blast may be regulated by a simple screw adjustment on the valve. It is easy to service and saves money by conserving air and eliminating the necessity of interchanging machine parts to achieve the results of a timed blast of air. With vent closed, it may be used as an air-control valve on any mechanism.

Tension Wrench with Flash Signal

IN the assembly of many products, and particularly in the automobile industry, it is often necessary to tighten nuts and bolts to a uniform tension. Wrenches with needle gages and others which produce a click when a certain tension is reached have been used in the past, but both types have their disadvantages in dark or noisy corners of factories. The Blackhawk Manufacturing Company solves this problem with a wrench called the Torkflash, which flashes



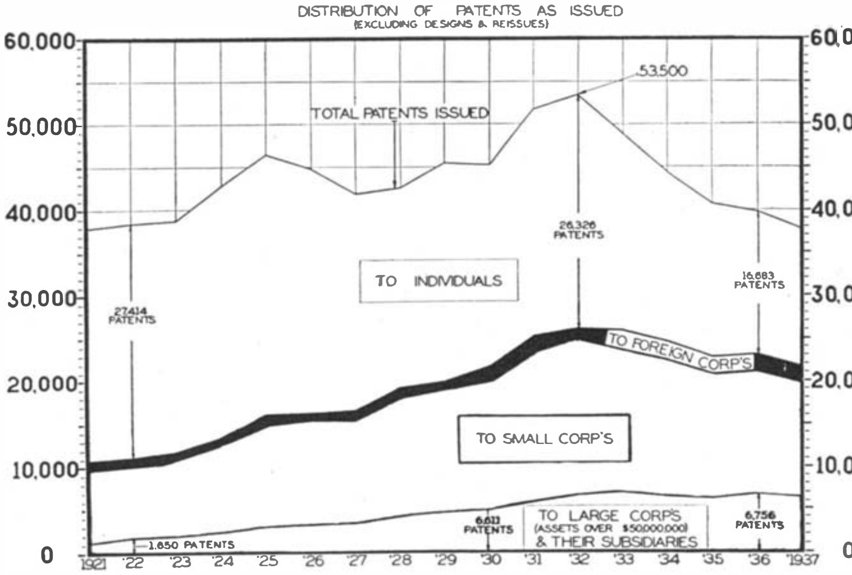
When the correct pre-set tension is applied to the handle of this new wrench, a signal light flashes a signal light when the pre-set tension is reached.

No mathematics is necessary to operate this wrench as the required tension is easily set by the five-in-one scale which slips over the cylinder enclosing the flash-light assembly at the base of the handle grip. This cylinder is rotated by finger pressure to show desired scale.

Torkflash has been tested at a capacity rating of 1400 inch-pounds for 87,000 mechanical pulls without affecting accuracy or strength of the wrench up to that point. Used at the usual range of 800 inch-pounds, it has been tested over 130,000 times and full accuracy has continued after that point.

Ice-Cooled Machine Guns

NEWEST use for dry ice is as a coolant for machine guns. A detachable jacket, filled with dry ice and slipped over the barrel, keeps the gun continuously cool. The scheme enables fighting planes and bombers to carry fewer guns, yet to maintain continuous fire.



An illuminating graph from the *Journal of the Patent Office Society*, which shows the total number of patents issued during each year, from 1921 through 1937. The distribution of these patents between individuals and corporations is particularly striking. It will be noted that, despite the impression that large corporations are obtaining the preponderance of patents issued today, their percentage is relatively small in comparison with the number of patents issued to small progressive corporations as well as to individual inventors

To Develop a Lifetime Tire

WITH child-sized machines, scientists of the Fisk Tire Company are working in a miniature rubber plant to perfect the tire of the future that will carry automobiles along super-highways at 100 miles per hour.

The miniature plant duplicates in every detail the gigantic factory machines used in standard manufacture. There are bins of compounds, mills and calenders for mixing rubber, a series of vulcanizers and presses—but all dwarfed in size. Grams are used instead of pounds. A laboratory rubber batch is one pound; a factory batch, 750 pounds. The small mill is 12 inches wide, the standard mill, seven feet.

Purpose of the miniature plant is to facilitate research work, speed operations by working with small quantities, and eliminate unnecessary waste.

Today these scientists are looking toward 1950. The future tire, they say, will be lighter and tougher, with greatly improved safety features. The carcass will be stronger to stand greater temperatures of high-speed operation. With decreased weight through redistribution of materials and through improved materials, greater flexibility will be secured, which in turn will provide better riding and wearing qualities. Treads will be tougher to stand up under increased mileage.

Eventually, they say, a tire will be made to last the lifetime of the car. In the meantime, when automobiles are ready to ride express highways, tires to carry them will be waiting—tires that were developed on these baby machines.

Rejuvenation Attempts Do Not Change Length of Life

THE length of a person's life is set by a hereditary time-clock or power of living that is in him when he is born, Prof. A. J. Carlson of the University of Chicago recently told members of the American College of Physicians.

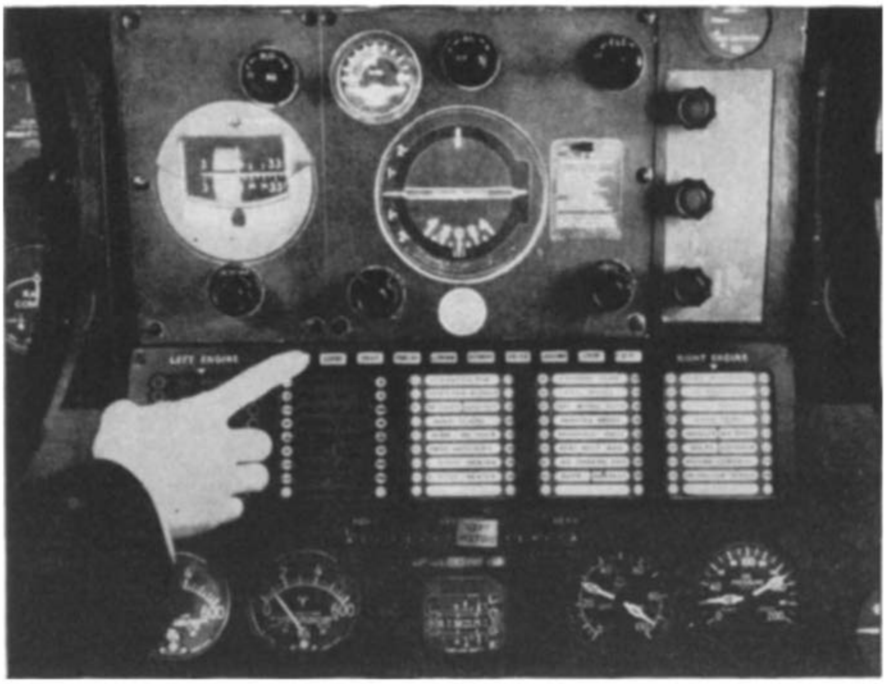
Contrary to the pseudo-science of rejuvenation, the sex glands are apparently not one of the links that determine the life span of the individual. They only determine the level and duration of the reproductive period of life. Man and animals, Prof. Carlson said, would still grow old, grow feeble, and die, presumably at the time appointed by the hereditary time-clock, even if they had no infectious diseases, ate the best possible diet, lived and worked under ideal conditions, and did just exactly the right amount of mental and physical work.

How work may affect the life span is largely an unwritten chapter, Prof. Carlson said. No work at all seems to lead to fatness and degeneration. Excessive physical work can apparently cause degeneration by exhaustion.—*Science Service.*

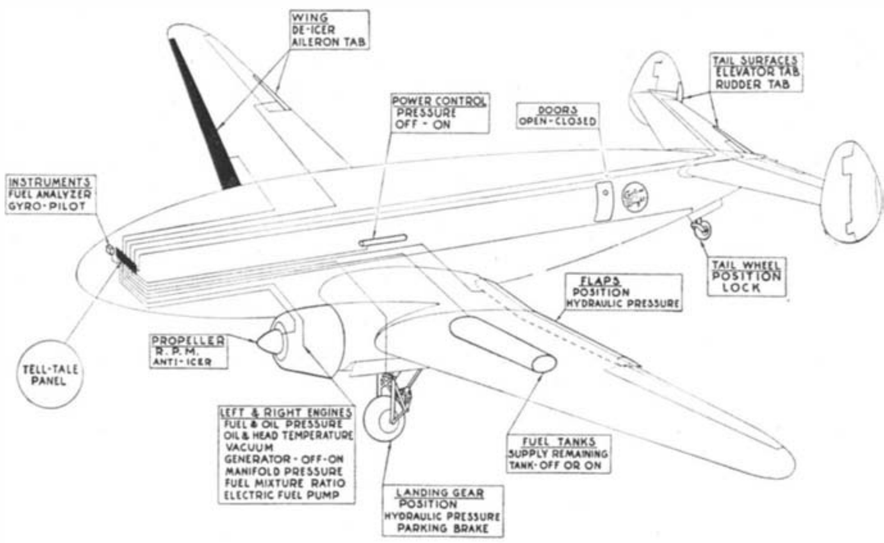
Benzoates Preserve Fish

DIPPING fish fillets in a very dilute solution of mixtures of benzoic acid and benzoates in salt brine prolongs the storage life considerably beyond that of untreated fillets. About 0.3 percent is the concentration of benzoates in the dipping solution. A dip of 30 seconds to two minutes

The miniature rubber mill, *left*, being used in tire development, compared with a full-size mill, *right*



Above: **The Tell-Tale control panel and, *right,* the airplane parts that are controlled from the panel**



affects only the surface of the fillet and leaves on it only about 10 percent as much benzoate as that used in the preservation of apple cider. The same treatment has proved effective with crab and lobster meat. Food laws require that fish so treated be labeled to indicate the presence of benzoates.—*D. H. K.*

Paint for Tires

RECOGNIZING the present upward trend of demand for white sidewall tires, The B. F. Goodrich Company announces a new white sidewall tire paint applicable for renewing white sidewall tires or for making present black sidewalls white.

Made with a rubber base, the new paint is self-vulcanizing, is elastic and thus flexes with the tire and will not crack or chip. This new type paint is applied with a brush, dries quickly and can be washed with soap and water without affecting its original whiteness.

Tell-Tale

THE new Curtiss-Wright *CW-20,* now nearing completion, should be a fine, efficient, and splendidly equipped transport. There is one novel device to be incorporated in it which deserves particular attention. This is the "Tell-Tale," developed to increase safety of operation and to decrease pilot fatigue by simplifying the task of control. In some respects the Tell-Tale is similar to the indicating signal systems used by the railroads and the electrical power industry to warn of danger or improper operation.

A panel of lights is placed on the instrument board. These lights are electrically connected to various vital operating parts of the plane, as indicated in one of the illustrations. The warning panel itself is shown in another illustration.

If the pilot wishes to land, he simply presses one of the ten pre-selector switches marked "Land." Lights immediately show on the Tell-Tale panel to indicate what adjustments are necessary. As the landing gear is lowered, the corresponding light goes out. As landing flaps and elevators are operated, their corresponding lights disappear. When the entire panel is dark, the pilot knows that it is safe to land.

If the pre-selector switch is directed to the right or left engine, lights immediately appear to warn of improper operating conditions as regards fuel pressure, oil temperature, head temperature, oil pressure, and other vital elements of engine operation. Other headings on the Tell-Tale speak for themselves.

Besides the Tell-Tale, many interesting features have been incorporated in the *CW-20* to reduce pilot fatigue and hence the possibility of accident. Thus, large, hubless, spokeless wheels on all instruments assure better vision of the various dials. There is a single-movement control lever for operating flaps and landing gear. Radio systems are duplicated. The landing gear retracts in five to six seconds, can be lowered in three seconds, and cannot retract while the plane's weight rests upon it. The icing hazard has been specially considered. Tests in a refrigerated wind-tunnel have resulted in an airfoil and hinge arrangement for the aileron which assures ice-free operation of this vital control. The carbureter is non-icing, and there are both pneumatic and liquid de-icers on the wings and tail.

We hope to give a fuller description of the new craft when its flight tests have been completed. Enough has been said here to indicate that our aeronautical engineers are fully alert to the need of greater safety for our airliners.—*A. K.*

Annual Report of the N.A.C.A.

THE complete annual report of the National Advisory Committee for Aeronautics contains dozens of deeply technical reports, and hundreds of printed pages. A summary of the giant volume is sent in advance to the Congress of the United States. It is interesting to pick out from this summary the results of the most significant research work, as an indication of the path that scientific aeronautics is following at the moment.

A better slotted flap has become available, which gives such a high lift capacity that landing speed is reduced more than ever before. The new type of flap increases lift without correspondingly increasing drag. Hence there should follow not only improved landing speed, but also improvement in take-off. A "Venetian Blind" type of flap has also been investigated, but details are not yet forthcoming.

There has been much research on the "tricycle" landing gear, also known as the nose-wheel landing gear. The tricycle landing gear has been widely adopted by constructors, but has a tendency to "shimmying." Various experiments have been made to diminish such shimmying.

Radiators for liquid-cooled engines should no longer be of the external type which produce so much drag. If the radiator is placed within a carefully designed duct in the wing, much of the drag disappears.

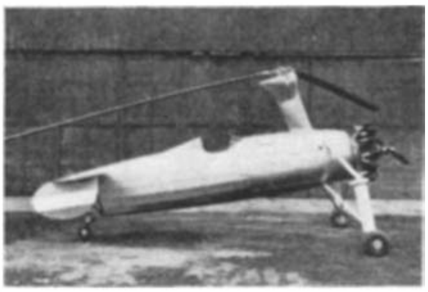
In the refrigerated wind tunnel it was found that ice formation on the leading edge of the wing decreased the maximum lift coefficient from 1.32 to 0.80, and increased the drag by 90 percent. This is, unfortunately, mathematical confirmation of the serious hazards of ice formation, particularly in hastening the stall of the airplane.

In its study of engines, the Committee has confirmed by tests what practical designers have long held—that the two-stroke cycle is most attractive for the aircraft Diesel.—*A. K.*

Mail by Autogiro

RUMORS have come true, and Eastern Air Lines has received from the Kellett Autogiro Corporation a wingless 'giro which will be used by the transport company in executing its United States mail contract covering the six-mile ferry route from the Central Airport, Camden, New Jersey, to the roof of the Philadelphia general post office.

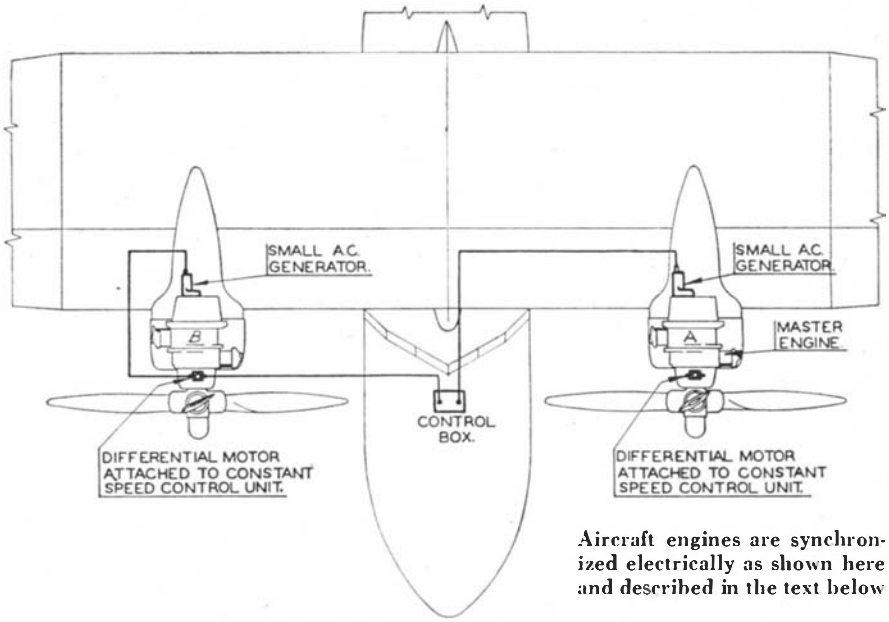
The Kellett 'giro is a one-place ship, with a large mail compartment, and will carry all the necessary instruments for blind flying and the exacting service of roof landing. The new craft is a derivative of the military 'giros which have done such excellent work with the Army Air Corps. High speed will



Mail-carrying 'giro

be 125 miles an hour, with low speed less than 25 miles an hour. The 'giro will land without forward roll and take off in less than 80 yards in still air. Specifications of the ship are: span, 40 feet; useful load, 620 pounds; weight empty, 1630 pounds; pay load, 150 pounds; gross weight, 2250 pounds; fuel, 30 gallons; service ceiling, 14,000 feet; cruising range, 200 miles.—*A. K.*

Synchronizing Aircraft Engines



Aircraft engines are synchronized electrically as shown here and described in the text below

WHEN the motors of a multi-engined airplane are out of synchronism, an annoying "beat" is produced. For example, a difference of only 20 revolutions per minute between two engines will cause a distinct "beat" every three seconds. Since it is difficult to read a tachometer to within 20 revolutions per minute, attempts by the pilot to synchronize the engines are difficult and tedious. Moreover, even after the engines have been brought to the same speed by manual control, rough air or variations in operating conditions may throw them out of phase, to the renewed annoyance of the passengers.

Hamilton Standard Propellers engineers have, therefore, sought to secure automatic synchronization, and have fully succeeded by a system which is both ingenious and simple in principle. When the engines are operating at approximately the same speed, the pilot merely flips a switch; the synchronizer then takes control and brings the engines to exactly the same speed and keeps them there.

A combination of mechanical and electrical principles is employed in the synchronizer. The actual change in speed is accomplished mechanically through adjustment of the constant-speed control on a particular engine, by increase or decrease of the propeller pitch. But the actual adjustment of the propeller control is effected electrically and automatically by a small differential three-phase motor attached directly to the propeller control.

The principle of operation of the differential motor is that it will not rotate when the frequency of the power supplied to one of its windings is the same as the frequency supplied to the other winding. Power for one winding is supplied from a small alternating-current generator driven by one engine. Power to the other winding comes from another alternating-current generator driven from the "master engine." If the speed of any engine differs by as little as a single revolution per minute from the speed of the master engine, a difference of phase is created in the windings of the differential motor, and the rotor is set into motion, changing propeller pitch until all difference has disappeared.

A very important feature of the differential motor is that its speed of rotation is directly proportional to the magnitude of the differences in frequency. Thus, as the engine approaches the speed of the master engine, the corrective action becomes slower. Hence there is no tendency to over-shoot the mark or to produce hunting.

Manual adjustment may be obtained at any time by switching off the synchronizer, but pilots naturally prefer the automatic system of operation, and the new device has been enthusiastically received by pilots and airline operators in general.—*A. K.*

Analysis of Landing and Take-off

AN important question in transport operation is the following: "Is it or is it not safe to operate certain transport craft in and out of certain airports?" To determine proper lengths of runways and the correct height and location of obstacles to approach or get-away, reliable information of landing and take-off characteristics under *service* conditions is necessary. Speaking before the Aeronautical Section of the National Safety Council, Major A. B. McMullan, of the Civil Aeronautics Authority, described a photographic system which has been developed by the Eastman Kodak Company for obtaining such vital information.

The essential equipment consists of four spring-driven motion-picture cameras with electrically operated single-frame releases. An electrical release mechanism is employed which gives absolutely correct timing. In practice, two pairs of cameras and two electrical controls are used. One pair of cameras is set on a short base of 60 feet, the other on a long base of 300 feet. With appropriate bases, markers, and so on, the airplane can be kept in view of the cameras throughout the take-off or landing process. Coördination of the films, timing devices, and so on, together with a projector on which the images produced by the two cameras of a pair are projected, and which is provided with reference markers, enables complete space triangulation to be carried out. A species of photographic surveying is thus accomplished. The final result is that a record is obtained of the exact position of the plane in horizontal and vertical distance at any instant of time. The value of such data is obvious.—*A. K.*

START-STOP

AMERICA operates approximately 16,000 passenger trains, and somewhere in the land a train is either starting or ending a trip every five seconds.

Alcohol Hair Tonics Plus Massage

WHEN alcoholic preparations are used on the scalp, vigorous brushing or massage should be used to stimulate the production of enough natural oil to offset any drying tendency they may have, according to the *Journal of the American Medical Association.*

This statement appears in answer to a physician's query on accepted modes of treatment for falling hair.

Among the preparations suggested by the *Journal* for arresting acute loss of hair is a solution of cresol in alcohol. A milder form of treatment which has been the "favorite" of dermatologists for many years is a 1 percent solution of pilocarpine in 50-percent alcohol or bay rum, according to the *Journal*.

"This is said to have a specific stimulating effect on the growth of hair, possibly related to its action on the vegetative nervous system."

Other formulations given by the *Journal* are the following: chloral hydrate, from 3 to 10 percent in 50-percent alcohol or bay rum; or mercury bichloride 0.3, resorcinol monoacetate 6, spirit of formic acid 20, in bay rum or perfumed alcohol to make 120.

FIGURES

PUT down the figure 10, then add 88 ciphers, and you will have the amount the voice is amplified by repeaters on a telephone call between New York and San Francisco.

Machine to Harvest Sugar Cane

NATIVE sugar cane cutters in Hawaii will stand awestruck when the monster cane harvester shown in two of our illustrations starts gobbling up stalks of cane like some starved mammoth which has chanced upon a field of particularly luscious grain.

This giant—compare its tire (7 feet in diameter) with the truck—started its journey recently to Hawaii where it will be put into operation by the Honolulu Sugar Planters' Association. Built as an experimental unit, the harvester will be "field-engineered"; any changes proved necessary by operating trials will be made by means of the truck shown, which is a traveling fabricating shop fitted with Lincoln Electric Company arc welding equipment, driven by power take-off from the truck drive shaft.

The sugar cane harvester was built for the Honolulu Sugar Planters' Association by R. G. LeTourneau Inc., and has been in process of development for many months. The idea for it grew out of a discussion of cane harvesting problems between Hawaiian cane growers and R. G. LeTourneau.

The cane harvester will cut the cane just below the surface, yet high enough to avoid injury to the roots. As it cuts the cane, the machine will pick up the stalks, take them into its cutting compartment, cut them into pieces approximately a foot long, then carry the pieces by conveyor mechanism to trucks or wagons which will travel along beside the harvester.

The engine installed in the harvester is a 160 horsepower Diesel built by Caterpillar. The large generator mounted on the front of the engine is for the purpose of furnishing power to electric motors which drive the conveyors and other operating mechanism.

This huge piece of machinery is successfully operated by only one man.

Conversation Timer

IN business offices where numerous long-distance calls are made or where overtime is charged on local calls, it is often considered necessary to time any given conversation carefully to avoid extra charges. In such offices a small clock-like device called the Phone-O-Meter would prove invaluable. Operated by a clock escapement, this meter may be set for any timing up to five minutes by merely turning the dial pointer by hand. Set at the beginning of a telephone conversation, it rings a bell a few seconds before the normal time is up.

To time talk

Paper Glaze from Corn

THE protein from corn is being used to make a glazing or coating composition for fine printing papers. This replaces casein from milk used in similar compositions.—*D. H. K.*

Blind Type Pull Rivet

A NEW type of rivet has been developed to be used in places where there is a blind side; that is, where one can work from the outside wall only and where heating, hammering, or upsetting are impractical. This new Hopkan blind rivet can be used for assembling the finest thicknesses of sheet metals, often where it is impossible to use other fasteners and rivets. Also, it may be used for fastening woven materials—such as upholstering to wooden or steel frames—or where it is desired to fasten boards to steel or Bakelite.

The male part of the rivet has a shank with a groove in it for pulling purposes. This is pulled through the slotted female part. The male and female are put through the structure from the outside with a pulling device. (Any standard puller can be adapted for use on the Hopkan blind fastener.) The puller holds the female, while the male is pulled to its proper destination, at which time the shank of the male automatically breaks off. This leaves the hole evenly filled, and makes a smooth finish, regardless of the shape of the head.

The rivet can be made from any type of steel, aluminum, or brass or other durable alloy. The head can be made button, flat or hexagon, and the rivet can be made in any size.

Chemical Eliminates Paint Odors

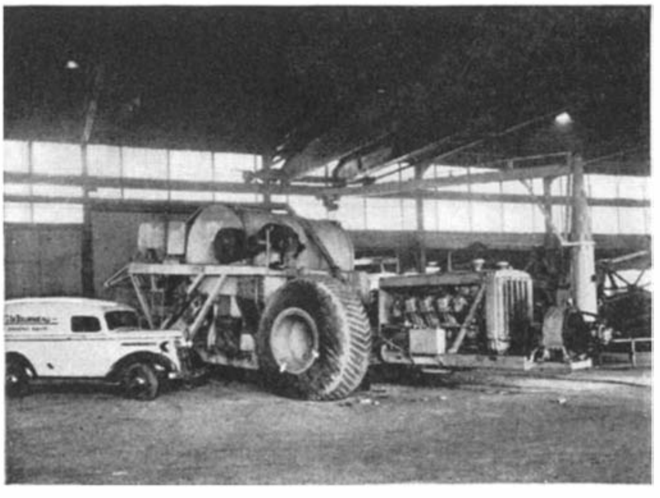
THE objectionable odor and eye smarting which accompany interior painting usually arise from the oils which the paint contains rather than from the volatile solvents. A new product, Santomask, added to the paint, will eliminate discomfort to the occupants. One or two teaspoonfuls per gallon are all that is required, and the chemical will not affect the normal characteristics such as drying time, durability, or color.

The manufacturer, Monsanto Chemical Company, claims that the new product will be especially advantageous for office buildings, hospitals, schools, hotels, and homes—buildings which frequently are occupied during redecoration and painting.

Explosion Damage

DAMAGE from one of America's major sources of destruction—dust explosion—can be materially reduced by scratching the outer surfaces of windows in factories where dust explosions are likely to occur, according to Hylton R. Brown of the U. S. Bureau of Chemistry and Soils.

Standard size panes, with a pair of diagonal scratches starting two inches from the edge and omitting a section two inches



Front and rear views of the new machine designed to harvest sugar cane across in the center of the pane, will break at such low pressures that the exploding dust will not have a chance to knock down walls, he indicated. Yet the window panes will be sufficiently strong to resist outside wind pressure.

Some such scheme is a necessary measure for "it is impractical to build walls strong enough to withstand the pressures produced," Mr. Brown pointed out. He recommended swinging vents as the most satisfactory way of getting rid of the dangerous dust-explosion pressures, but pointed out that such swinging windows could be installed in existing buildings only at great expense.

Unscored window glass, particularly of the "double-strength A quality" most widely used in factory construction, is much too strong to vent the force of an explosion successfully, he indicated. The window frame itself may go first when such a glass is used.

Property damage in excess of $35,000,000 and deaths in excess of 300 have been caused by dust explosions in the last two decades.

Dividing a building with unpierced walls was another of Mr. Brown's suggestions. It would prevent the spread of the explosions. Explosive dusts include a wide variety—starch, grain, wood flour, sulfur, cork and others being among them.—*Science Service.*

That Highway White Stripe

SOME time ago a nationwide search was conducted for the originator of the center traffic safety line on highways, the "white stripe," by The B. F. Goodrich Company, and the honor was awarded to the late Edward N. Hines of Detroit, vice chairman of the Wayne County Board of County Road Commissioners and a prominent figure in highway and highway safety activities for many years.

A plaque was presented to Mr. Hines to commemorate his great contribution to highway safety, a method now being used internationally.

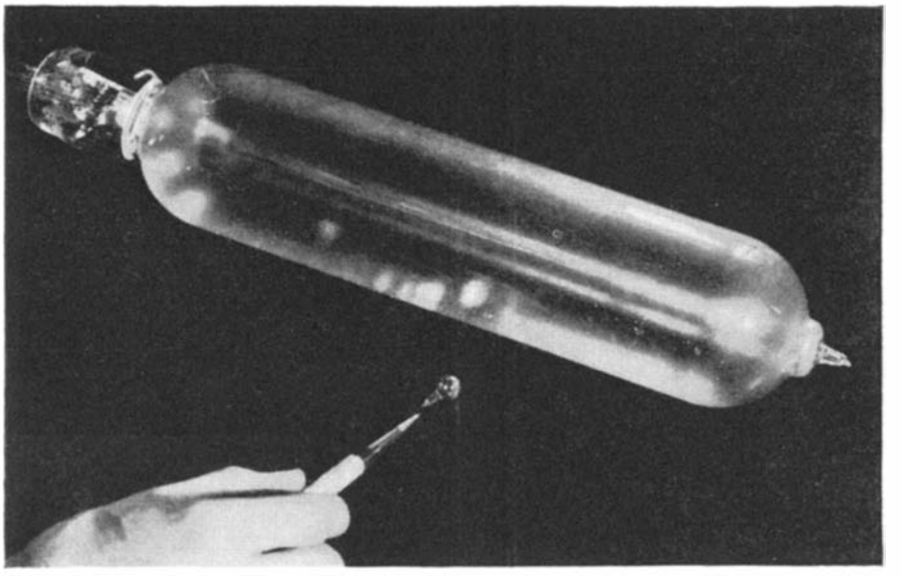
His origination of the center traffic stripe was in 1911.

Now comes Alexander L. H. Darragh, of Chicago, who submits a photograph of a section of old highway between Mexico City and Cuernavaca, Mexico, built under the Spanish regime 350 or 400 years ago, and clearly showing that the "white stripe" was in use even then.

Traffic dividing stripe on a Mexican road built some 400 years ago

This stone road, many sections of which are in service today, being used mainly by foot travelers and light animal-drawn vehicles, has a "built-in" center line of light-colored stones.

Mr. Darragh took the photograph at a point where the old road intersects the new and modern highway to Mexico City. He gives no historical reason for creation of the "white center line" but believes it might have been put in, even in those days of comparative antiquity, to prevent quarrels between those ancient travelers who wanted to be sure they got their half of the road for their burros and wagons.



***Above:* One of the sodium bombs compared with the tube in which it will be used. *Right:* Final stage in the production of the bombs. Filled with triple distilled sodium, they are ready to be sealed and removed**

Sodium Bombs

GETTING a pinch of sodium into the sodium vapor lamp, the golden-orange lamp which is becoming increasingly common in highway lighting, is a complex problem, the solution of which involves the explosion of a "bomb" smaller than a marble.

The sodium lamp consists of an evacuated tubular bulb with an electrode at each end. When the current is turned on, the sodium, showing as a mirror-like deposit when the bulb is cold, is vaporized and becomes the current conductor, giving the bulb its characteristic golden-orange color.

The problem is to get the required amount of pure sodium—about 1/80 ounce—inside the vacuum tube without exposing the sodium to air. A tiny bomb, a glass bulb containing pure sodium, does the trick. Making the miniature bombs is a complicated process in itself. Before being sealed within the miniature bomb, the sodium undergoes a triple distillation. Attached to the fourth vessel of the distilling system by slim necks, or capillary tubes, are the glass cases of the sodium bombs. In its final distillation the sodium is deposited in the capillary tubes. Argon gas is released into the system to force the sodium from the necks down into the bulbs. Heat is then applied to the necks to seal off the bulbs and remove them.

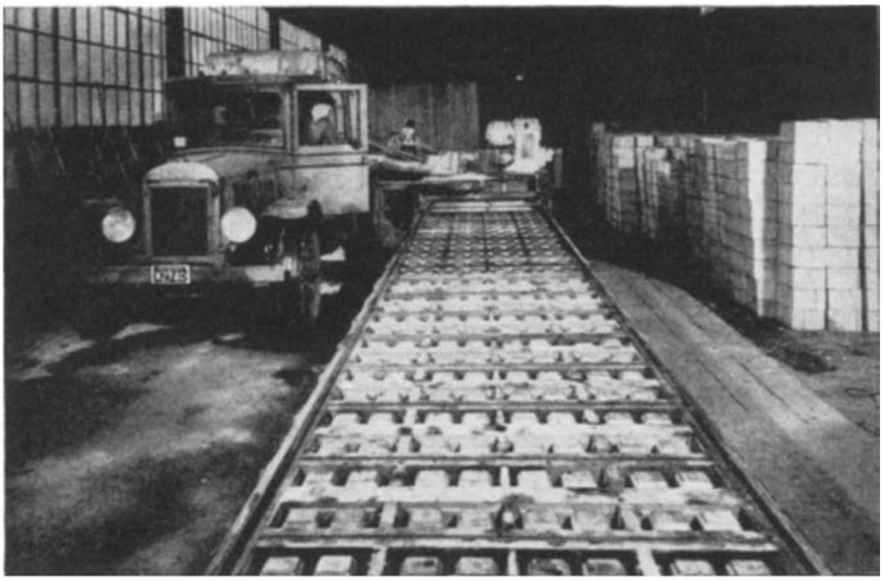
After the sodium bomb has been placed in the lamp tube and the tube has been evacuated, a high frequency coil is placed around the tube. This coil induces heat in any metal within the tube, by a sort of "wireless" or radio process. It causes the sodium inside to melt, to heat still further to the boiling point, and to explode its glass bomb.

The sodium is thus deposited on the walls of the lamp. Its glass case is shattered by the explosion into countless pieces. Since the glass case of the bomb is at the most six thousandths of an inch thick, the shattered pieces are hardly more than dust, which can be left in the lamp.

Before the miniature bomb explosion method was developed in the General Electric Company's Research Laboratory, the sodium was distilled separately into each lamp.

On Making Feather Dusters

THE recovery and use of feathers has long been an organized business, and vast quantities of them have been diverted to various uses—including feather dusters. In making dusters the feathers are drawn through a metal ring to regiment the quills. Light as they may be, the feathers have a protective structure of tiny, tough scales that scratch and eventually wear out this metal ring. One manufacturer found his rings worn so rapidly as to mean serious nuisance and expense. In succession, various



harder metals were tried—several types of steels, then Stellite, then Carboloy. As none was entirely satisfactory, he asked for suggestions from an ingenious worker in metals.

The successful solution was an exact reversal of the direction in which previous attempts were made. Little is known of the ultimate nature of friction, and the term "hardness" is all but meaningless without a description of the manner of its measurement or the nature of the opposing forces. Hardness as measured by penetration of a steel ball may have no relation to hardness measured by depth of groove under a diamond cutter. It is therefore difficult to predict wear or friction with unusual materials or conditions. The microscopic surface of feathers presents an unusual combination of abrasive properties of surface, composition, and shape. Rubbed against what the inventor called "brute hardness," minute particles of metal wore away, whereas lead, not rigid, but pliable, apparently flowed back and forth under the pressure of the feather surface. Lead was proposed and pure lead rings now wear almost indefinitely.—*The Industrial Bulletin* of Arthur D. Little, Inc.

ELECTRICITY COST

THE electric current consumed during its lifetime by an ordinary 15-cent, 60-watt electric lamp costs at least ten times as much as the lamp itself. Hence, even a 1 percent increase in the efficiency of a lamp will make a sizeable difference in its ultimate cost.

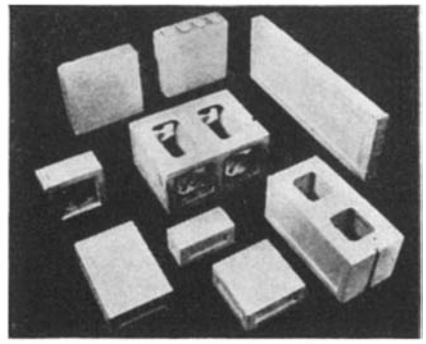
Pre-cast Concrete Shapes

PITTSBURGH, the city that gave the world standardized structural steel, now has become the birthplace of standard pre-cast concrete shapes, which simplify fireproof construction and lower its cost through mass production.

Use of vibration, heat, and mass production methods are the three main features of the system of manufacturing Cemenstone, as the pre-cast material is known. Vibration while molding is said to produce a finer texture and a stronger product. Heat is used to hasten the chemical reaction of the cement when it is brought in contact with the other materials and water. It also is said to induce uniform shrinkage and a product of a uniform light color. Mass production has been made possible by the development of a system which permits rapid cycles of manufacture and the making of several shapes at one operation. The method of molding, curing, and aging produces elements with sharp edges and corners so that they have the appearance of cut stone.

Among the products which can be produced by this method are blocks for wall construction and channel-shaped, short-span slabs for floors and roofs, as well as long-span slabs, concrete plank, joists, brick, insulating tile, and veneering, also curbs, sidewalks, and fence posts.

The production equipment consists of a rigid steel frame over a curing chamber which produces a temperature of 160 degrees, Fahrenheit. A hopper, which fills the molds with concrete, mixed to a plastic state, rides on the top of the frame, together with vibrators which agitate the mix. Steam from the curing trough keeps the molds constantly hot. After the concrete has hardened sufficiently the products are lifted out in large groups and unloaded for aging under cover and in a constant temperature, to prevent unfavorable weather conditions from arresting the proper chemical reaction within the concrete.



***Above:* Pouring the mix at one end of the continuous production Cemenstone mill. *Right:* A few of the pre-cast concrete shapes that can be produced with the same equipment**

Designed to speed up sweeping of sidewalks and floors in industrial plants, the "Flying Dust Pan," invention of R. C. Howell, a Cleveland industrial engineer, is powered by a one-horsepower motor and mounted on General Streamline Jumbo Jr., pneumatic tires. It runs at a speed of about three miles an hour and can turn around in its own length. Picking up any type of dirt or debris, from fine dust to stones as large as hens' eggs, the sweeper can be manipulated to work within an inch and a half of a factory wall

Copper Cures Fungous Diseases

COPPER, passed through the skin by electric current, is being successfully used in treating fungous infections of the hands and feet by physicians at Yale University Medical School.

In the past, many remedies have been used to treat these painful and abhorrent skin infections without spectacular success. Of 37 patients treated at Yale by means of electric current, 26 have been discharged as cured. Some of them had severe infections of long duration, one for as long as 25 years. The average number of treatments given was six.

The afflicted person sits with his feet immersed in enamel pans and with the hands in other basins. When the infection is on the feet, the hands are immersed in salt solution and the feet in 0.2 percent copper sulfate solution. For infections of the hands the relations are reversed. The duration of the treatment is 20 minutes. Special apparatus has been devised to obviate the danger of electric shock.

Dr. Howard W. Haggard, Dr. Maurice J. Strauss and Leon A. Greenberg described the new treatment in a preliminary report in the *Journal of the American Medical Association.—Science Service.*

Rubber-to-Metal Cement

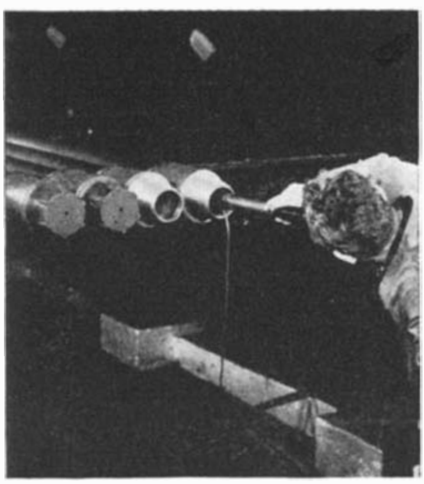
THERE has long been need for a cement which will stick many different kinds of materials, including rubber, to metals. Such a cement has been developed by the St. Louis Rubber Cement Company and is available in all size packages from one ounce to 55 gallons. This product, which is called Griptite Cement, is easily applied, can be made to be a quick or slow dryer, and to withstand any climatic conditions. The manufacturers claim that the longer it sets the more tenacious it is.

Griptite is made from a combination of rubber, selected gums, and chemicals. The result is a cement that "welds" rubber to metal, anti-squeaks to metal, rubber to enameled metal, felt to metal, blue wadding to metal, cardboard to metal, and linoleum to metal and concrete.

Tube-Wall-Scope and Magnaflux

TWO new procedures involving a recently developed instrument, the Tube-wall-scope, and a new application of the Magnaflux method are now being used to inspect, during production, both the interior and exterior surfaces of every length of J & L Blue Ribbon seamless steel integral joint drill pipe manufactured by the Jones & Laughlin Steel Corporation.

The Tube-wall-scope fills a long-felt need for an accurate, scientific method of inspecting the inside of tubular goods for defects which eventually might result in pipe failures in the field. The Tube-wall-scope is a precision instrument resembling an exceptionally long telescope. It is equipped with an adjustable focus eyepiece at one end and a series of special lenses, reflectors, and a specially designed high-powered light at the other. The lenses are arranged to permit the operator to inspect the complete 360 degrees of circumference inside any tubular product as the Tube-wall-scope is pushed slowly through the pipe. Guide baskets mounted on



the barrel serve to center the instrument in the pipe.

As the Tube-wall-scope magnifies the size of the image of a defect, an experienced inspector can quickly recognize any flaw as a possible source of failure and by calibrations on the instrument barrel can then readily determine the location of a defect.

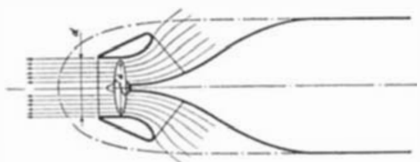
Every length of integral joint drill pipe now being produced by the company is also subjected to the Magnaflux test. This drill pipe eliminates the conventional type tool joint by having a forged upset tool joint integral with the pipe itself. The Magnaflux test is applied to the exterior of this forged upset to detect defects not visible to the eye in the desire to attain a perfection of surface that will materially reduce the possibility of failures at the joint.

This test consists of placing the pipe in a magnetic field and then sprinkling the pipe with a metallic powder or solution. Even though not otherwise visible, any defect will immediately become apparent as the red powder is attracted by magnetic action to a flaw and collects there.

The Kort Nozzle

AN appendage which is installed permanently on the stern of vessels to surround the propeller as a sort of tube, and called the Kort nozzle, is being rapidly adopted for use on small vessels. This device, which is handled in this country by the Dravo Corporation, produces an additional effective thrust from the screw propeller without increasing the load. It is intended for use on well-designed vessels but is not for use on poorly designed ones. It has no moving parts, no connection to moving parts, consumes no power, and is physically as strong as the hull itself.

The duty of the Kort nozzle is to control the direction and velocity of the water pass-

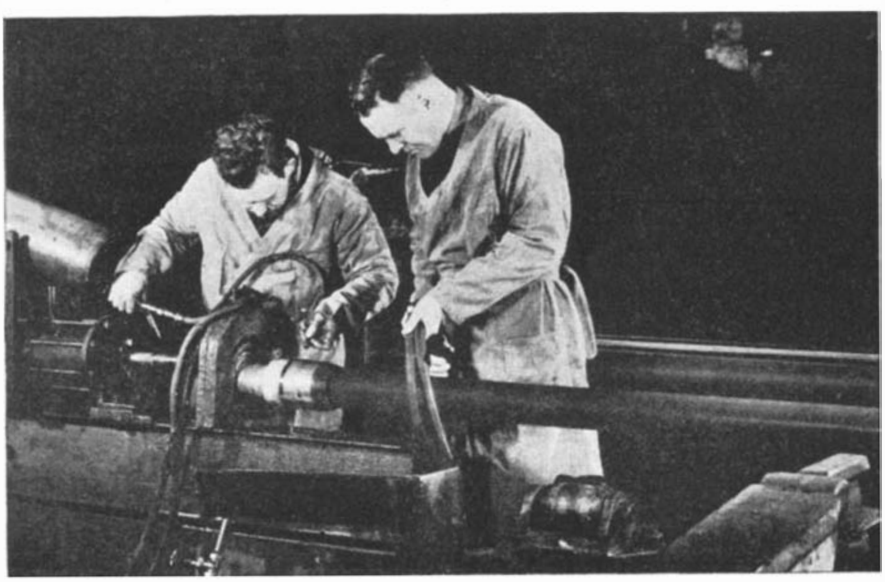


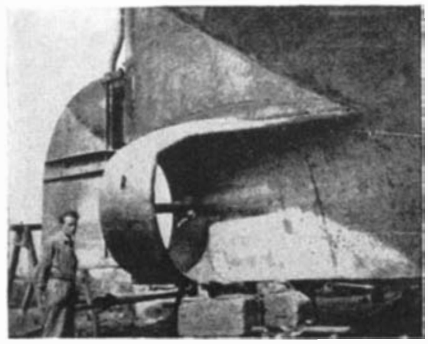
How the Kort nozzle drives a cylindrical column of water sternward, thus obtaining a "productive push"

ing to, through, and away from the propeller, with the further duty of obtaining additional forward thrust through the control of the suction value of the propeller "draw" on the hydrofoil sectioned ring. The underlying principles through which this nozzle gains its superior propelling efficiency are not unduly technical yet are too long to explain in detail here. Generally speaking, the action of the propeller is to drive sternward a cylindrical column of water and from this propeller race, "productive push" is obtained.

For coast-wise and harbor towing vessels an increase of tow-rope pull between 20 per-

Left: The Tube-wall-scope in use. *Below:* With the Magnaflux test, invisible pipe defects are detected





The Kort nozzle installed on the Dutch motorship *Joma*. See text

cent and 35 percent may be expected at normal towing speeds. The case of the Motorcoaster *Joma* of Groningen, Holland, will serve as an example. Trials made in calm water over a measured mile without the Kort nozzle gave a speed of 7.83 knots with the engines developing 225 S.H.P. at 298 revolutions per minute while the *Joma* was consuming 89.4 pounds of fuel per hour. After the application of a Kort nozzle, on the same course and under similar sea conditions, the vessel attained a speed of 8.6 knots with the engines developing 219 S.H.P. at 322 revolutions per minute and consuming 87.0 pounds of fuel per hour. The gain was 9.85 percent in speed with a reduction of 2.7 percent in fuel.

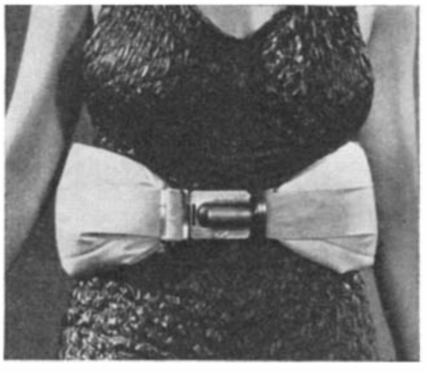
A New Joint

A NEW electric welding process, successfully adopted in a number of industrial plants, provides rapid, automatic making of welds of low-carbon and medium-carbon steels, stainless and other alloy steels. The "Unionmelt" process uses as an electrode a bare welding rod automatically fed, heated by the passage of an electric current from it to the work being welded. The end of the electrode is constantly covered by a special granulated material which is automatically laid down in advance along the seam to be welded.

The granulated material used is a high-resistance conductor of electricity in the molten state, and hence makes possible the use of very high current densities which cause rapid generation of intense heat. It also acts as a heat insulator and concentrates the heat in a small welding zone. The molten portion floats as a liquid blanket over the weld metal, protecting it from the atmosphere, and the actual welding takes place beneath this liquid blanket, without evidence of an arc, and without sparks, spatter, smoke, or flash. By using various combinations of amperage, voltage, and welding speed, the shape and the reinforcement of the weld can be varied and the depth of the fusion zone can be regulated as desired.—*The Industrial Bulletin* of Arthur D. Little, Inc.

New Life Preserver

THE belt worn by the bathing girl in our illustration is the invention of G. J. Peterson of North Dakota, who spent almost four years in its perfection. It inflates and quickly becomes a life preserver in an emergency. The Swimaster, as it is called, has the appearance of a handsome swimming belt, uses ordinary Sparklet siphon cartridges available at all drug stores, and



There is nothing unusual in the appearance of the swimming belt shown at upper right, but it can be instantly inflated to act as a life preserver, as pictured above

can be used over and over again. A slight squeeze of the belt buckle inflates the Swimaster to a buoyancy more than sufficient to float the heaviest person, even in hunting clothes, from 12 to 16 hours or more, *in swimming position!*

Hunters and fishermen may wear the belt under clothing where it will remain inconspicuous and still operate efficiently.

Pennies Saved

HOUSEWIVES' habit of utilizing the bags in which sugar, flour, rice, and other similar materials are delivered to them, has at last stimulated ink makers to action. A new series of printing inks to be used to print labels on such bags gives impressions which are satisfactory so long as needed, but which can be readily washed out by the housewife. By using pigment inks with these removable ones, part of the design can be left on the cloth if desired. Still other inks will leave a stain in the cloth when washed out with soap and water.—*D. H. K.*

Old Mathematical Puzzle Still Intrigues

ONE of the great mysteries in the history of mathematics is known as Fermat's last theorem. In the year 1637, brilliant Pierre Fermat, great French mathematician, wrote in the margin of an algebra book this statement:

"If n is a number greater than two, there are no whole numbers, a, b, and c such that a^n plus b^n equals c^n. I have found a truly wonderful proof which this margin is too small to contain."

Unfortunately, after Fermat's death in 1665, an examination of his papers showed that he never wrote out this "wonderful" proof. And in so doing Fermat left a mystery

which probably every first rate mathematician since his time has puzzled over at least once.

Many of Fermat's mathematical followers spent entire lives on the problem and at least three large cash prizes (one in 1907 amounting to nearly $25,000) have been offered for a solution to Fermat's moment of inspiration. Like some modern movie or cigarette contest these prizes produced a veritable avalanche of "solutions," mostly from amateur mathematicians, and all false proofs. The present status is that the theorem has been proved for values of n less than 617.

Reporting recently to the American Mathematical Society, Dr. J. Barkley Rosser of Cornell University described a method of treating a special, simplified form of Fermat's famous theorem so that many values of n can be handled at once. With this method he has proved this special case for all values of n less than 8,332,403.

This special form puts on the restriction that the number n must not divide a, b, or c. Previously Dickson, in 1908, had proved this case for numbers up to 7000 and, in 1925, Beeger did it for numbers up to 14,000. By comparison Dr. Rosser's contribution is enormous.—*Science Service.*

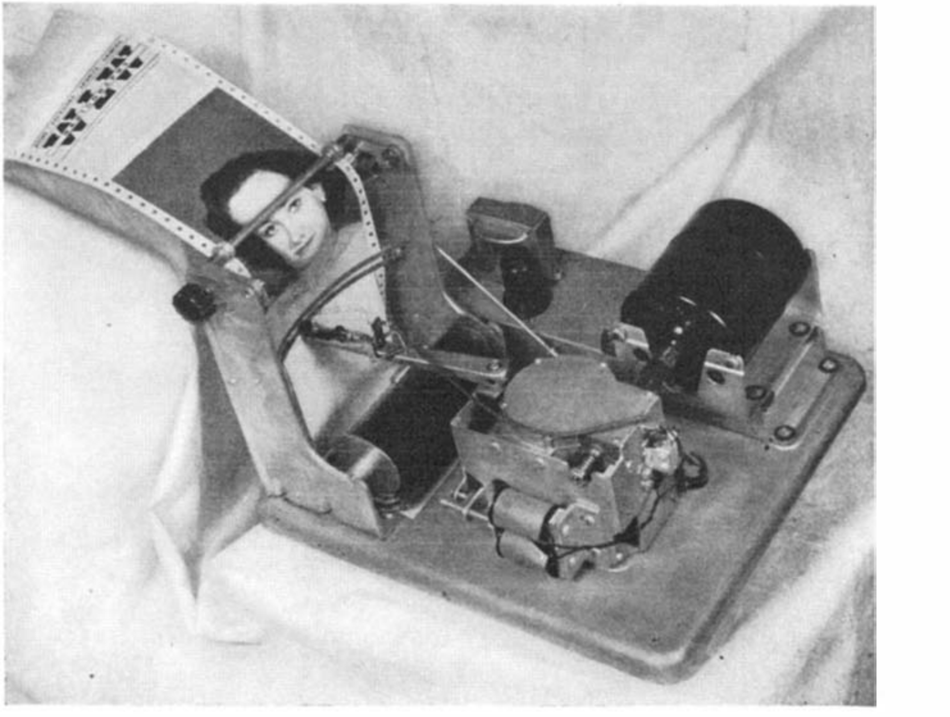
ILLUMINATION

"SIGHT is precious," says the Washington Water Power Company, Spokane. "It is estimated we use our eyes for severe visual tasks about 30 percent more than was common a generation ago—and many times more than a century ago."

For Homebuilt Radio Facsimile Receivers

THE amateur who likes to build his own radio receivers can now add another interesting radio development to his accomplishments. He can secure the parts and build his own facsimile radio printer. Because of the great interest aroused by this latest development in radio, The Crosley Corporation has prepared a kit containing all the parts necessary to build a Reado facsimile printer which the amateur can operate in connection with his own radio receiver.

Facsimile radio printing is in its infancy today just as radio itself was 20 years ago, and with the possibility of radio printing coming into widespread use in homes and in other places as yet untouched, the radio amateur has a highly interesting field in which to carry on his experiments.



Facsimile recorder which can be constructed from an available kit of parts

The Crosley Reado radio printer is a development of the Finch method (See Scientific American, June, 1938) and is being used in many places throughout the country. The time probably is not far distant when radio facsimile printers will constantly deliver an interesting stream of timely news items and pictures of news events, as well as other information, into homes and other places.

Control for Peach Borer

Ethylene dichloride, widely used in fumigating grain, has proved more effective in controlling peach borers than many materials now used, and in addition it is easy to apply with little danger of injury to the tree and is relatively cheap. Ethylene dichloride is emulsified with water containing potash fish-oil soap; and this emulsion is poured about the base of the tree. The treatment can be given to trees of any age and can be applied at any season.—*D. H. K.*

Sear Off Steel Surface Defects

Flashing, searing flame is removing the bottleneck in the otherwise high speed, mechanized production of steel from the ore pile to the warehouse of the finished product. That bottleneck was the stage known as bloom finishing, when the surface defects in the steel had to be removed to meet customer demands.

Flaming torches, burning oxygen and acetylene gas, are now searing off the outside surface of giant billets in many steel mills of the land. They are replacing older methods which employed many men to chip off the defects with pneumatic chisels or huge machines—power-operated but man-controlled—which did the same thing.

Flame scarfing is the name of the new method. The steel makers have been reluctant to talk much about it until it had achieved a success over an appreciable period of time, in full scale commercial production. They had been fooled, too many times before, by other methods claimed to have solved the problem of bloom finishing. But that trial period is now over and grins are replacing skeptical frowns on the faces of the nation's steel masters.

The Lin-De-Surfacer is the name of a flame scarfing device coming into increasingly wide use in steel plants. It takes its best position in the steel mill's otherwise continuous chain of production when it is placed in the blooming mill near the giant shears that cut off chunks of steel a foot in diameter and 10 or 12 feet long.

These chunks, the blooms, go through the flame-cutting treatment, lose their surface defects and pass on to the rolling mills.

In actual operation the bloom passes into the unit and its surface is pre-heated, to the point where it just begins to flow, in about two seconds. This is accomplished by multiple torch openings which may number as many as 28 orifices. Then, at the proper instant, along comes oxygen gas and sears off the outer surface to any depth desired up to a quarter of an inch.

In the de-surfacing unit the blooms move against the blast of oxygen flame at a rate which can be as high as 175 feet a minute. The oxygen velocity is low, in contrast to the high speed flame of the ordinary oxy-acetylene cutting torch, and peels off the surface. The slag formed consists of about 80 percent iron and can be used over again to charge blast furnaces.—Copyright by *Science Service.*

PLASTICS

IN 1926, production of plastics in the United States was 10,000,000 pounds. A fast jump to 30,000,000 pounds was made by 1932, and an enormous increase to 162,000,000 pounds in 1937.

Calomel, Valuable Insecticide

DOSING cabbage maggots with calomel applied in a suspension around the young plants, as a dust, or as a coating on the seed, has distinct advantages over most other methods yet devised for combating this troublesome pest, according to Dr. Hugh Glasgow, entomologist at the N. Y. State Experiment Station at Geneva.

The insecticidal properties of calomel were discovered largely by accident a number of years ago in some tests at the Station in which all of the salts of mercury were included as a matter of routine, explains Dr. Glasgow. Such striking control of the root maggot was obtained on the calomel plat, however, that it was immediately made the subject of careful tests, with the result that it was found to have some decided advantages over corrosive sublimate, the standard treatment, although no more effective than the latter in controlling cabbage maggot.

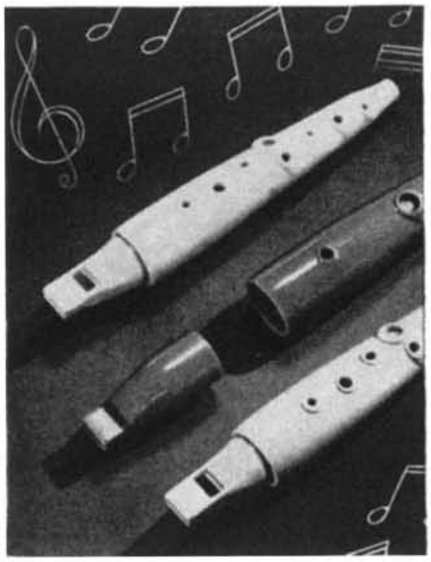
One of the chief advantages that calomel possesses is that there is little danger of injury to tender young plants from its use, whereas corrosive sublimate must be used in a fairly dilute solution and even then may cause injury to cauliflower and radish seedlings. Corrosive sublimate is also suspected of delaying the harvesting date of early cabbage and cauliflower. Because it can be used in heavier dosages, calomel generally does not need to be applied as often as corrosive sublimate.

Calomel may be applied in suspension in water, as in the case of corrosive sublimate, or it may be used as dust, or it may be applied directly to the seed at planting time. "In fact, any method that results in placing the calomel near the point where the eggs of the insect are normally deposited should result in satisfactory control of the root maggot," says Dr. Glasgow.

Tonette: Newest, Simplest Musical Instrument

ALL his life, Zeigner Swanson liked to tinker with flutes, to play them and to build them. It is said that flutes are as old as willow branches and a tool to cut them; and "Zig" has amassed a collection of them showing their evolution from hollow willow twigs through sterling silver flutes of modern design to the Tonette.

The Tonette was evolved from the desire of its inventor to bring music-making to the masses. It is 7½ inches long, chromatic and tuned to the piano. The finger holes are arranged for ease in playing; and, by lifting one finger at a time, *in succession*, the scale is produced. The range is an octave and a



Tonette is made in two parts

third, so that a wealth of material can be played upon it—favorite tunes, simple classics, popular melodies, and so on. And already considerable music has been specially arranged for it. The Tonette is made of Tenite, an unbreakable plastic material. Its tone is really a cross between that of a clarinet and a flute. Everything learned on the instrument carries over directly into the study of all other instruments. That is why music educators are adopting it as standard pre-band equipment for young music students. Its dollar price brings it within the reach of every child, and gives his parents an opportunity to see whether he has what it takes to learn to play—either for his own amusement or for any other purpose—before investing in a high-priced instrument. It is also used by professional bands for novelty effects and is ideal for adults who never had an opportunity to study music—for anyone can play it without a single lesson.

Preserving Hay

THE addition of a form of phosphoric acid to alfalfa and timothy is recommended as a method of preserving these crops so that they can be stored without drying and curing in ordinary silos. Waste by mildew and other causes is said to be eliminated by this new, inexpensive treatment.—*D. H. K.*

Valuable Products from Lignin

BY adding hydrogen to lignin—chemistry's problem child—scientists of the U. S. Forest Service's Forest Products Laboratory at Madison, Wisconsin, have learned how to convert this waste product of wood into products that bear promise of being valuable raw materials with many uses.

One is a well-known product—methanol, or wood alcohol. Four others had not been previously discovered, although one of the group was described as theoretically possible by a German scientist. The properties of these new substances are such as to suggest their use as wood preservatives, fungicides, insecticides, adhesives, solvents, and plastic materials.

The co-discoverers, Dr. E. C. Sherrard and Dr. E. E. Harris, describe the first new substance as parapropylcyclohexanol, valuable as a solvent for organic gums and resins, and oils used in lacquers. It has value as a preservative, and is about as repellent to insects as creosote.

The second and third substances, described as 4-propyl, 1, 2-dihydroxycyclohexane and 3-p-hydroxycyclohexylpropanol, are thick liquids which become solid after standing a long while. Both may be made into plastic materials.

The fourth substance is crystalline and unnamed, as the discoverers have not yet determined the positions of the carbon, hydrogen, and oxygen atoms of which it is composed.

Because of its complex chemical nature, lignin in its natural form has baffled scientists. By submitting it to the hydrogenation process, the Forest Service scientists changed its chemical nature so that it could be broken down into component parts. The hydrogenation process already is in use commercially in making hard fats from vegetable oils, in making petroleum oils from coal, and in getting phenomenal yields of gasoline and gas oils from natural petroleum.

In the laboratory tests the hydrogen atoms were added to a solution of purified lignin by means of heat and pressure and the use of a catalyst—copper chromium oxide—another chemical inducing rapid reaction, yet taking no part in it. Under this treatment the dirty, brown lignin solution changed to a thick, sticky, and colorless fluid. The catalyst was removed by the use of a centrifuge, which works on the principle of a cream separator. The residue was then distilled, or fractioned, to create the wood alcohol and the four new substances.

99.9999 PERCENT

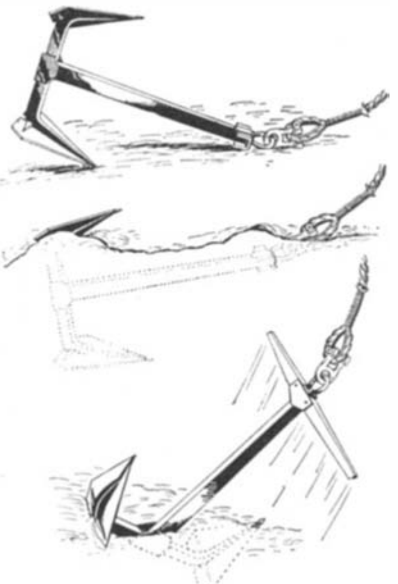
PURITY of metals is difficult to achieve, yet very important in research, alloy making, metal coating. Metallurgists have made lead 99.9999 percent pure.

FOLDING, LIGHT-WEIGHT ANCHOR

ONE of the latest developments in the marine accessory field is a new light-weight anchor fabricated from high strength Monel sheet. It is welded throughout, except where the arms and stock meet the shank. These joints are pinned so that the anchor can be folded for stowing when not in use.

Made in a variety of sizes from six pounds to 47 pounds in weight, the anchor is so designed that the 11-pound size will hold a boat 38 feet in length. With the conventional type of anchor, the general rule is to allow one to two pounds in anchor weight for each foot of boat length. This lightness of weight is made possible by the design of the anchor, combined with the inherent strength of Monel.

Arms of the unit are set at right angles to the stock and are equipped with a set of sharp-pointed triangular flukes. These dig deeper and deeper as the pull of the craft is increased. The broad palms of the anchor, which will bury themselves completely in bottoms of clay or sand, provide an exceptionally strong grip. The anchor will not dig itself out of the bottom until a direct upward pull is exerted on the line. Then the sharp-pointed flukes readily cut their way out.



The light weight and small size of the anchor permit ease of handling and reduce the danger of damage to the hull and topsides. Monel is highly resistant to corrosion and the anchor will not rust in fresh or salt water.

This anchor was designed and is manufactured by the Youngstown Welding & Engineering Company.—*Inco.*

Rubber-like Substance from Dairy By-products

Scientists of the U. S. Bureau of Dairy Industry have perfected a process for making a transparent rubber-like substance from lactic acid of whey that has many promising uses in various industrial operations.

Known to chemists as polymethylacrylate, the water-white semi-solid material is closely related to the so-called organic glass made synthetically and used for highway reflectors. It is softer and more flexible than organic glass, however, but is very tough and elastic.

Laboratory results obtained by Lee T. Smith and H. V. Claborn, chemists in the Bureau's Division of Dairy Research Laboratories, indicate that polymethylacrylate can be produced as cheaply from lactic acid by their method as it is now produced from ethylene or alcohol by the cyanhydrin process. The Bureau scientists believe the cheapness of their process will contribute to the increased use of lactic acid.

Because of their unique properties, polyacrylates are already in demand for various purposes. Their transparency, elasticity, toughness, ease of solubility, and stability to sunlight and ultra-violet rays make them especially valuable in the preparation of lacquers, varnishes, inks, impregnating compounds, and cements.

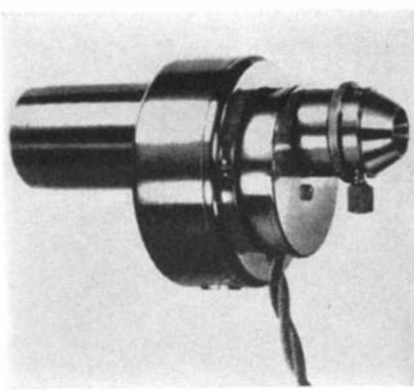
All types of fabrics, paper, and other fibrous materials may be coated or impregnated with the polyacrylates to make them resistant to water, oil, and gases. Fabrics with these characteristics are useful in making ship's sails, balloon cloth, and clothing for protection against poisonous gases. Treated paper finds many uses, especially in the electrical industry.

Unlike the related organic glass material, polymethylacrylate alone is not suitable for making molded objects, either by the compression or injection method; but it can be combined with the organic glass to make a molding material superior to any of the original compounds.

Radiation Pyrometer

A NEW radiation pyrometer which uses as a temperature-sensitive unit, the Ardometer, shown in the illustration, is being offered by The Bristol Company.

This instrument measures the surface temperature of hot objects or masses above 1000 degrees, Fahrenheit, when the Ardometer unit is sighted so that it picks up the



heat rays emitted. The temperature is recorded on a round- or strip-chart recorder or is indicated on a millivoltmeter pyrometer.

The Ardometer has this important feature: it can be sighted directly on the object in the furnace and in this position it measures instantly the temperature of the object itself. It follows with fidelity the temperature changes in the material on which it is sighted.

Liquid Metal Polish

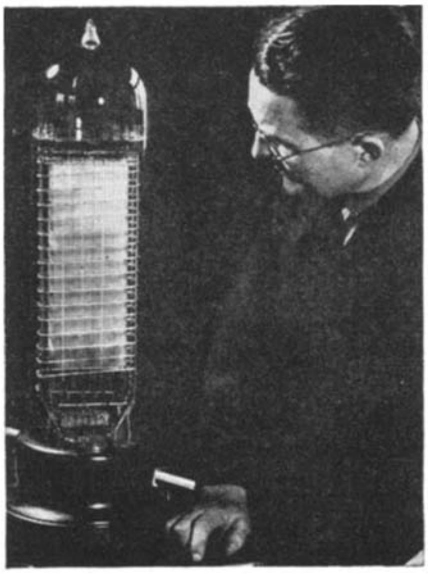
A FORMULA for a liquid metal polish developed in Germany is given as follows: Dissolve 8 parts of fatty acids in 15 parts of denatured alcohol; saponify with 4 parts of ammonia (sp. gr. 0.91); add 2 parts of fatty alcohol sulfates; dissolve in 58 parts of benzine and stir the solution with 50 parts of fine Neuburger chalk.

Electron Stream Harnessed

RESEARCH engineers of the Westinghouse Electric & Manufacturing Company have made electrons obliging actors for the visitors to the New York World's Fair.

To show what goes on inside a three-electrode vacuum tube and the effect of a magnetic field on a stream of electrons flowing through a vacuum, the engineers have built a triode 27 inches high and seven inches in diameter. It is similar to a standard radio tube except that it has two filaments and two grids on opposite sides of the plate so that the action is visible from both directions. This interesting tube is shown in one of our illustrations.

The surface of the plate is coated with fluorescent material, so that wherever electrons impinge on the plate, a green color shows. By changing the negative biasing voltage supplied to the grid, the stream of electrons to the plate can be varied from zero to the maximum of which the tube is capable. A pattern on the face of the plate shows the area normally bombarded by electrons.



The action of electrons in a vacuum tube is made visible in this demonstration model, as described

By placing a permanent magnet near the tube, the electron stream can be deflected by the magnetic field. The effect of the field on the electron stream can be seen plainly. This effect varies according to the way the magnet is applied to the tube.

The circuit used is similar to that in audio-amplifiers. A 60-cycle frequency is applied to the grid and the tube output is connected to a loud speaker. The loudness of the audio signal corresponds to the area of the green glow on the plate of the tube.

Sulfapyridine in Pneumonia Cases

ALMOST all deaths from pneumonia could now be prevented if pneumonia patients were given proper treatment on the first day they were taken sick, Dr. Perrin H. Long of Johns Hopkins School of Medicine recently told members of the American College of Physicians. The millennium of no more pneumonia deaths, which probably could be achieved by the new chemical remedy, sulfapyridine, will probably never be reached, Dr. Long said, because pneumonia patients do not see a doctor on the first day of sickness—in fact, usually not until they are desperately sick.

Serum would not be necessary in the treatment of pneumonia, Dr. Long said, if sulfapyridine could be given the patient the first day of his illness. From the standpoint of cost alone this would be a tremendous advantage. It costs about $12 to treat a case of pneumonia by sulfapyridine but the cost of serum treatment is at least $75. Serum is not always available, whereas sulfapyridine is both available and effective in all types of pneumonia.—*Science Service.*

RAILROADING'S LATEST CHAPTER

(Continued from page 361)

with a gear reduction unit. The turbine operates at a speed of 12,500 revolutions per minute and the diameter of the high-pressure rotor is approximately 12 inches. The gear reduction unit has a ratio of about 10 to 1. A main traction generator composed of two armatures mounted on a common shaft and in a common frame is connected to the turbine. A three-phase alternator is mounted on the main generator shaft to supply alternating current used in the passenger car for lighting, air conditioning, and, on some trains, part of the heating load.

A 50-gallon, self contained boiler of the water-tube, forced-circulation type and using distilled water, furnishes 45,000 pounds of steam per hour for the turbine at 1500 pounds per square inch pressure and at a temperature of 920 degrees, Fahrenheit. The steam is passed from a superheater through the high pressure turbine and then through the low pressure turbine. Then, instead of being exhausted as it is on the reciprocating steam engine, it goes from the low pressure turbine to a condenser and is returned to the boiler in the form of water to be used over and over again. Only small quantities of distilled water are required to make up losses. No more than a few tankfuls would be required by the steam-electric locomotive on a coast-to-coast run. Compare this with the thirsty steam locomotive which may use as many as 200,000 gallons of water hauling a standard passenger train from Chicago to the Pacific Coast!

A 4000-gallon water tank of steel construction is installed in the nose of each cab of the steam-electric locomotive, this water being used for the most part in furnishing steam heat for the passenger cars.

ELECTRIC energy from the turbine generators is fed to six traction motors of the axle-mounted type on each cab. Each of the motors has a nominal rating of 600 horsepower. In addition to furnishing driving power for the locomotive, these traction motors have another important function. They provide electric braking essentially the same as that used for regenerative braking in the straight electric locomotive. This dynamic braking, as it is called, is used both for service stops and for controlling the speed of the train on long down-grades. On the steam-electric locomotive, it will hold the train on a 2.2 percent down-grade at any speed desired, without the application of any brake shoes on either the locomotive or the train.

The motors become generators in the braking process and the power they generate is transmitted to a water-cooled resistor, a series of pipes through which water is forced to dissipate the heat generated during electric braking. The water leaves the resistor as a mixture of water and steam, passes into the condensers, and is returned to the condensate tank.

A 3000-gallon tank for the two-cent-per-gallon fuel oil is installed near the rear of each of the cabs, next to the condensers.

An ingenious control system maintains steam flow in proportion to the load on the turbine, as well as a constant steam pressure. When the engineer moves the throttle ahead, the control functions to increase the amount of fuel, water, and combustion air to the boiler, and the demand for more power from the generating plant is satisfied. The process is simply reversed when the engineer decelerates the locomotive. The ratio of the fuel, combustion air, and water supplied is a fixed relationship, regardless of the main power demand.

An auxiliary turbine set drives a combustion air blower, feed water pump, and fuel oil pump through gear reduction units. Getting the locomotive "steamed up" preparatory to running is a simple matter compared with the process of getting the standard steam locomotive ready for service. A small vertical fire-tube boiler with a capacity of 100 pounds of steam per hour is used. Propane gas serves as the fuel in this boiler. If steam can be secured at a roundhouse or from some other external source, the main boiler can be started without the use of this auxiliary boiler.

The running gear of each unit of the steam-electric locomotive consists of two main driving truck frames, each carrying three driving axles. The two-axle guiding trucks pivoted to the main truck frames complete the running gear of a 2-C-C-2 wheel arrangement.

Crew space is up front, instead of at the rear of the unit as in the reciprocating steam locomotive, and from his comfortable chair the engineer can look out over the snub nose of the steam-electric locomotive and get a clear and unobstructed view of the track ahead. A defrosting system and wipers keep the windshield clean in sleet, snow, and rain storms. The engineer operates the locomotive by manipulating two controller handles and the usual air brake system; and as a final modern touch he even has a handset telephone handy at his elbow so that he can be in instant touch with other members of the crew.

What effect this new steam-electric locomotive will have on the future of American railroading, only time can decide. Among already-known advantages, the steam-electric locomotive has a thermal efficiency from fuel to the driving wheels more than double that of the conventional locomotive. Its ability to travel as far as 700 miles under favorable conditions without stops for fuel or water, plus inherent high rates of acceleration and braking due to high adhesive weight, are important factors in maintaining high-speed schedules on long runs. There will be savings in brake shoes and wheels for the entire train as well as for the locomotive as a result of the electric braking. Boiler trouble should be rare, due to the use of distilled water in a closed system which eliminates corrosion and boiler scale.

It is certain that the performance of the new steam-electric locomotive over the historic line between Chicago and the west coast will be watched closely, for it represents the latest manifestation of that "breeding" of unlimited possibilities to which Horatio Allen referred 110 years ago.

Conducted by **JACOB DESCHIN**

Camera Adventures in Washington

THIS month we relinquish the chair to a guest conductor, no less than Mrs. Camera Angles, herself an enthusiastic fan, who describes the opportunities for picture-making which she found on a recent visit to the Nation's Capital.

UNLIKE most national capitals, Washington is very democratic, photographically speaking. Except for the Smithsonian Institute, where the picture possibilities are limited anyway, and the Senate and House galleries, where they would be unlimited, not only are you permitted to carry your camera into public buildings but the guards encourage you by pointing out interesting picture possibilities. This camera fan took pictures mostly of exteriors of buildings in the atmosphere of cherry and magnolia trees in full bloom. However, many striking views can be taken from the windows of the Capitol, the Congressional Library, and other public buildings. From the top of the Washington Monument which towers over the city, you can—if you can elbow your way successfully to the windows before other camera enthusiasts monopolize the best vantage points—get interesting bird's-eye-view shots of Washington.

"Washington Sunset"

Of all the buildings, the Lincoln Memorial lends itself best to picture taking because of its dominating position on the banks of the Potomac, and the wide spaces around it which permit the photographer to view it from every possible angle. Its majestic pillars cast striking shadows against the dazzling white walls. From the top stairs, front, one gets a sweeping view of the Potomac; from the back, an interesting view of the reflecting pool extending from the Washington Monument to the Lincoln Memorial which, on a clear, windless day, mirrors both structures.

Other interesting picture possibilities are to be found in the Botanical Gardens, with its bewildering array of plants, flowers, trees, and so on, from all parts of the world, in tropical or other natural settings. You can stroll unmolested through the White House grounds (inside it is necessary to check cameras) but visitors are permitted to view only a few rooms. The White House lends itself to interesting shots both by day and by night, when it is brilliantly illuminated.

"Public Model"

If, however, you don't take to buildings, exteriors or interiors, you can always wander down to the Tidal Basin—if you happen to be in town during the cherry blossom festival. The shot reproduced here was taken on such a stroll when the sun was playing hide and seek and the picture had to be focussed in advance and snapped the moment the sun came out of hiding. You can walk clear around the basin along a path which hugs the water's edge. If the view from the water's edge does not intrigue you sufficiently, you can hire a boat and try your luck from the water.

The Tidal Basin always attracts a good crowd and something interesting is bound to happen. The picture of "Daniel Boone" was taken the first day your photographer arrived in Washington. "Daniel Boone," spotting our camera, greeted us with a hearty smile and an even heartier offer to pose—at a price. A little nonplussed, we scorned his offer until a more charitable photographer of the male sex took him up on it. To express his appreciation, Daniel showed the young man, and an ever increasing throng which crowded around him, pictures which had been taken of Daniel in a Russian costume by a dentist photographer in the U. S. Navy. He also showed us pictures in which he appeared with Hedy

"At the Concert"

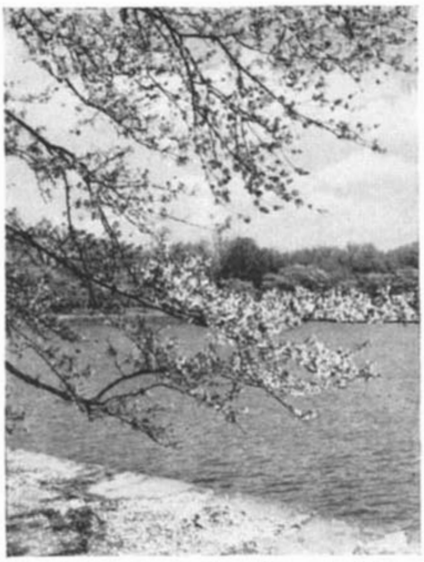
Lamarr in connection with one of her recent movies.

Relenting, we accepted his offer but had considerable difficulty in getting him away from the crowds as well as inducing him to avoid posing. As his photographic income soared, he became even more loquacious. He is apparently a well known character and takes parts in historical pageants, fairs, and so on. Two young ladies from Philadelphia identified him as having ridden in a historic carriage during a celebration there. To us, Daniel confided boastingly that he expected to be at the World's Fair with Ford or some other exhibit. All the while, he never for a moment lost sight of prospective photographic victims. If an uncharitable photographer tried to shoot without paying, Daniel would pursue him, with the crowd after him, crying out that this was money he needed for food and lodging. When we finally parted, we gave him the address of Mr. Camera Angles in the event that he does turn up for the World's Fair.

Just before leaving the scene of this adventure, we could not resist taking a shot at the sunset on the waters which, though ordinarily like a mirror, had been made turbulent by a strong wind. Fortunately, we had remembered to bring a lens shade, for without it, this picture would not have been attempted.

On our last day in Washington, Marian Anderson was singing before a record crowd at the Lincoln Memorial. Because one of the guards had said he would be "shot" if we tried to slip under the ropes which held back the throngs, we had to content ourselves with leaning over the ropes and shooting from that vantage point.

The camera made many new friends for us. We found this time, as we had on so many previous occasions, that not the least of the



"Cherry Blossoms"

values of sightseeing with a camera are the exciting adventures to which picture taking invariably leads.

Cameras at the World's Fair

WE have it on the word of the officials of the New York World's Fair that photography by amateurs will be freely permitted and, in fact, encouraged. The only restrictions on this score are that professionals will be barred since the professional concession at the Fair has been awarded to Underwood & Underwood. Incidentally, the Eastman Kodak Company will do its own large bit by sponsoring photographic exhibitions by various organizations and by helping amateurs in their exposure and other photographic problems at the Fair. One of these helps will consist of specially built backgrounds against which the amateur may photograph his best girl, and vice versa.

Press Cards

THE notion seems to have gone abroad that a press card is something that may be purchased and automatically will admit the holder to all functions. The only press card of any value is one issued by the Police Department of the particular city in which pictures are to be made, and money will not buy it. It is issued only to accredited working press photographers associated with specific newspapers. In New York City, the press cards are distributed by a central news bureau, to which the cards are entrusted by the Police Department, and are issued for three months at a time.

Print through the Back

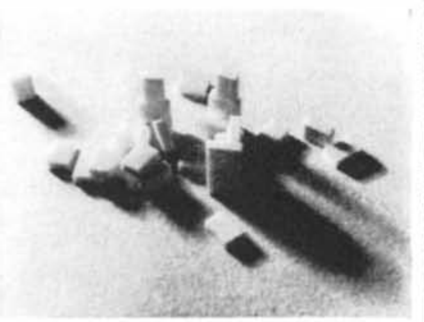
IF your negative looks too sharp for the picture's good, you may find the solution in projecting your negative through the back of the printing paper rather than by the normal procedure of directly onto the emulsion. The negative is reversed in the holder—that is, with the emulsion side facing the lamp rather than the lens—and the paper is turned upside down. If your easel has any metal or other bright parts built into it, cover the easel with an ordinary sheet of paper and then place the printing paper, face down, on top of it. Either single weight or double weight paper may be used, the double weight naturally requiring a longer exposure than that needed for the single weight.

New Photographic Term

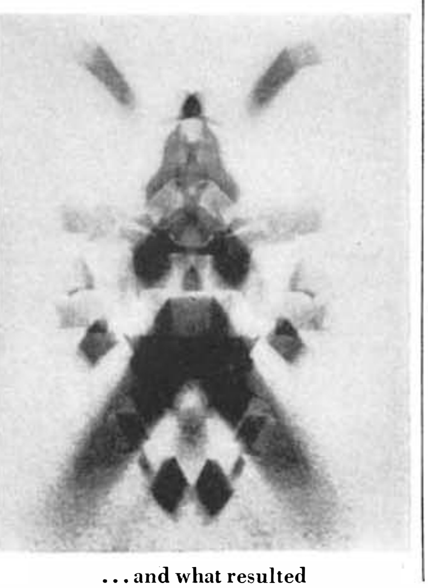
THE ever-widening use of exposure meters of all types has recently brought into vogue a brand new photographic term describing the act of using a meter to "read" exposure. The term is "expometering" and is introduced by Joseph M. Bing, F.R.P.S. It seems that photography is destined to make its influence felt in the dictionary as well as the many fields it already touches.

"Design in Sugar Cubes"

TWO separate exposures of a simple set-up of sugar cubes with no other thought in mind than to give one a little more time than the other, provided the inspiration for the combination of the two negatives reproduced here. Accidentally, one day, the two negatives being enclosed in the same glassine pocket, we looked at the negatives against a light and saw what we thought was an unfamiliar negative. Actually, the two negatives were so positioned that they provided a strange pattern very much resembling a caricature of a human figure. So the two were placed in the enlarger as they were, with the emulsion side of one facing the easel and the emulsion side of the other facing the light. A rather long exposure was required,



Start of an inspiration . . .



. . . and what resulted

for one reason because two negative densities were being exposed, for another because of the overall density of the individual negatives. Had the job been done according to a pre-conceived plan, a darker background would have been employed in order to provide greater transparency, although in that case the shadow effects would have been less pronounced.

"Kitten on the Window Sill"

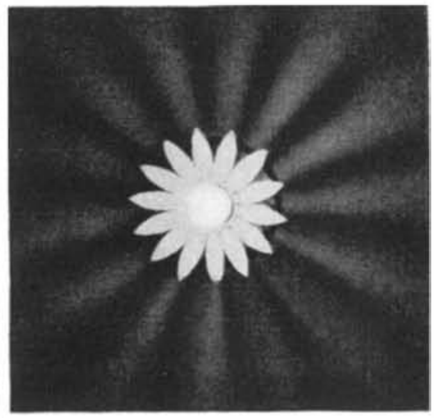
EVERY morning, some time before eleven, this white kitten sits on the window sill of the apartment just below ours, bathes itself in the sun and surveys the world below it. Our appearance at the window above attracts her attention and she watches us through one of the window panes, particularly attentively if we happen to have a camera in hand. One such morning, it occurred to us to expose a negative to this matutinal habit and the picture you see is the result.

"Kitten on the Window Sill"

In making the enlargement we lined up the edge of the wall with the long side of the print in order to overcome the tilt in the camera position necessitated by the subject. The angle is, however, identified by the diagonal lines of the upper and lower parts of the window as well as the diagonal lines of bricks.

"Corridor Ceiling Light"

THE opportunities for pictures that lie even in humdrum subjects is illustrated by this shot of the interesting pattern surrounding a small ceiling light. Waiting for the elevator sometimes has its advantages, for it was on one such occasion that we happened to be studying the ceiling—for lack of something better to do—and, noticing the practically symmetrical arrangement of the pattern "leaves" all around the lamp, thought of the camera hanging idly from the shoulder. It required a low, crouching position and a straining of the neck, the camera being of the range-finder type, to get into as central a position as possible under the circumstances, short of lying on the floor. At the full $f/2$ opening of the lens and with fast panchromatic film, we made three shots, at 1/10, 1/25, and 1/50 of a second. Although we knew we could not fail to record the light, our chief concern was with the shadows which were projected upon a relatively dark ceiling. Also, because we were shooting directly into a light source, we expected flare



"Corridor Ceiling Light"

and were not sure just where this would strike the film. In one of them, luckily, the flare struck just outside the ring of shadows and we were able to make a print by excluding this flare spot through appropriate cropping. The square composition was inevitable because of the nature of the subject.

Photographic European Tour

THE picture train idea, started some time ago, has now risen to greater heights to assume the ambitious proportions of a First Annual Photographers' Grand Tour of Europe. Organized by the Walker Travel Agency, of Ridgewood, New Jersey, this first European photographic tour, by private motor coach, is to have as its photographic leader and mentor, the well-known pictorialist, Edward A. Alenius, F.R.P.S., who will be the lecturer, advisor, and consultant on all phases of photography.

The tour will begin on August 11 and will last through September 25, during which period the following countries will be visited: England, Holland, Belgium, Switzerland, Germany, Italy, and France.

Annual Leica Exhibition

THE annual assembly of the best Leica photographs made during the course of the year is now under way. Leica users are advised that no specific restrictions are placed on the choice of subject matter, which may be a portrait, an aerial, candid, action, medical, animal, insect, or any other type of picture. Actual color prints made from Leica color transparencies are also invited, as well as sequence pictures.

The rules announced for submitting prints to this, the Fifth Annual Leica Exhibition, are as follows: There is no limit placed on the number of prints that may be submitted; prints should not be less than 8 by 10 inches in size; prints may be submitted mounted or unmounted, but if mounted, the mounts should be of a light color and conform to the standard sizes; on the back of each print or mount, the photographer should include his name and address; the lens used; shutter speed and diaphragm opening; film used; developer for the film; filter, if any, as well as other accessories used to make the picture; and, if possible, the name of the paper and the developer used to make the prints. Contact prints should accompany photographs but should not be pasted on the mounts; all packages should be addressed to E. Leitz, Inc., 730 Fifth Avenue, New York, N. Y., and should bear the word EXHIBIT in the lower left corner.

SHOOTING IN THE BACK

OCCASIONALLY you run across a subject, such as a broomstick vendor, with brooms of various descriptions jutting out from under his arms and over his shoulders, which presents an opportunity for a shot in the back. These persons are usually on the go so it will be necessary to follow the subject and shoot as best you may. A good way to keep him in focus is to set your camera for a given distance, walk briskly or slowly, as the case may be, until you reach this distance between camera and subject and let the latter's walking speed pace your steps. When the moment seems ripe, shoot quickly and use a relatively fast shutter speed as a precaution against camera unsteadiness at the moment of exposure.

WHAT'S NEW

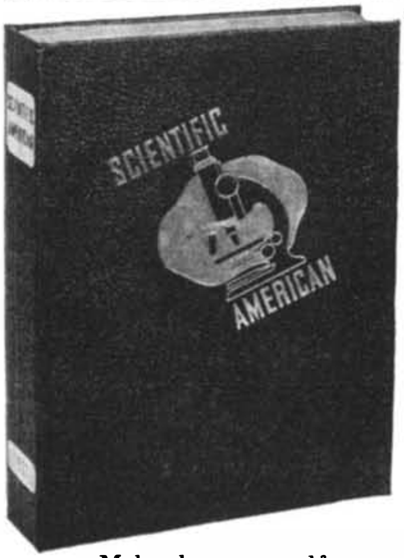
In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

ROBOT MODEL II: Newly designed model with features including optional fitting of Zeiss Biotar $f/2$ lens and Zeiss Telephoto Sonnar $f/4$, 7.5cm. In addition to Model I features, Model II offers new film magazine for Robot daylight spools, as well as all films wound on standard 35mm cores; bulk film may be used with or without spool; built-in flash bulb synchronizer coupling, for use with new Robot Sequence Flasher, permitting sequence photography at night. Flashgun changes electrical contact from one bulb to next automatically, and operates as fast as shutter release can be worked, camera shutter being its own synchronizer.

PIERCE EXPOSURE METER ($1.85): Optical type meter. Entirely pre-settable, no calculations required. Film speed and filter factor, once having been set, need not be changed until filter or film is changed. Each meter complete with neck cord and packed in individual box complete with instructions for operation and listing in Weston system of 79 different emulsions. Two models available, for motion picture and still cameras.

MODEL C OMEGA ENLARGER ($97.50): For all negatives from 35mm to 3¼ by 3¼ inches. Enlarger design similar to that of Model D, with side negative troughs. Enlargement ratio 8½ times with 3½ inch lens,



20 times with 2 inch lens; larger by projecting image on floor. Rigid steel post four feet tall. Interchangeable lens boards accommodate lenses of various focal lengths. Baseboard of seasoned laminated hardwood measures 18 by 27 inches.

KINGSLEY SQUEEGEE CLEANER: Special chrome and ferrotype cleaner. Removes grease, dirt, finger marks. Can be used on any style ferrotype tin or chrome plate.

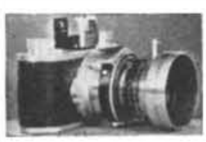
FALCON-FLEX TWIN-LENS REFLEX CAMERA ($5.95 or $7.95): American-made reflex camera. Choice of two lenses—Faltar or Achromatic. Picture size 2¼ by 2¼ inches, 12 exposures to the roll. Introduced by manufacturers as the "first American-made reflex camera of this style."

HYPO-SHARP: ($1): Reagent for hypo in wash water. Shows presence of hypo by instantaneous change from deep blue-black color to water white. End-point much sharper and test far more sensitive than permanganate test usually prescribed. Hypo-Sharp shows one part of hypo in 50,000 parts of water. Set includes reagent ready to use, sufficient for 500 tests, two graduated tubes, and handy tube support.

ALBERT AUTOMATIC ENLARGING EASEL: Automatically centers, squares up, aligns and holds three standard sizes of enlarging paper —11 by 14 inches, 8 by 10 inches, and 5 by 7 inches. No shifting of easel when changing from one size paper to another. Masking bands hold automatically in fixed position and positive contact assures clean margins. Inlaid rubber strips prevent slipping from set position. Non-warp, non-mar base. Finished in rust-proof chrome.

ABBEY BACK SHUTTER SYNCHRONIZER ($12): Designed for use with focal plane shutter. Features include easy adjustment as to timing; battery case may be used on either side of camera with no interference when coupled range finder is employed; automatic cut-out switch gives added safety, permitting shutter to be rewound at any time without danger of blowing off bulbs in socket; single wire connection in battery case eliminates need for special wiring; extension lever provided without extra cost.

KODAK COMBINATION LENS ATTACHMENTS: Constitutes series of uniformly threaded units, each fitting others and all fitting an adapter ring which slips on or screws into lens mount of camera. Each attachment unit available separately. Adapter ring is basic unit; only one such ring required to mount any combination of attachments on lens. Adapter Ring and one Filter Retaining Ring provide filter mounting. All of the more than 100 Wratten filters are available, cemented in "B" glass circles

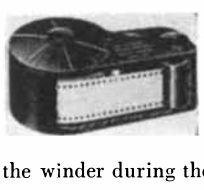


to fit attachments. With two Filter Retaining Rings, filters may be used in combination if desired. Pola-Screen may be used directly on Adapter Ring or in combination with filters. Two Pola-Screens may be employed if desired. Kodak Lens Hood (aluminum) may be used with Adapter Ring alone, or with filter, combination of filters, and Pola-Screen. Adapter Rings available to fit lens mounts from ¾-inch diameter to 2½ inches.

SURE-X ELECTRIC PHOTOMETER ($4.25): For properly timing exposure time in enlarging. Incorporates Bunsen "grease-spot" principle for matching light; double moving scale converts measurement into usable information on paper grade and exposure time. Used to measure scale of negative, if desired, to determine proper grade of paper to use; paper factor of any given batch of paper; and exposure time for each negative while latter is in enlarger, giving exposure in seconds or minutes, directly on face of dial. Also useful in making color pictures by Chromatone, wash-off relief, or carbro process, scale being used as densitometric comparator for learning depth of tone and color intensity.

LEICA SYNCHRONIZED FLASH UNIT MODEL V ($19.50): Battery and reflector firmly attached to tripod socket of Leica camera baseplate, while compact synchronizing head slips into Leica accessory clip and lies almost flush against back of camera. Short length of electric cord extending behind camera joins two parts of flash unit, making one compact instrument of camera and synchronizing equipment. Entire unit mounted or dismounted in less than a minute. Unit designed for use with wire-filled bulbs. Lamp reflector may be set in two positions, low position for properly centering Superflash Press bulbs and higher position for Superflash No. 2 lamp.

DE LUXE MODEL DAYLIGHT FILM WINDER: Holds 100 feet of 35mm bulk film. Bakelite housing molded to take standard 35mm magazines and Leica, Robot, or Contax cassettes. Besides counting exposures, winder is constructed so that film emulsion does not touch any part of the winder during the loading process.



SIX-BY-SIX EXAKTA REFLEX (price varies with lens equipment): New Exakta model featuring 12 exposures 6 by 6cm (2¼ by 2¼ inches) on standard No. 120 or B-2 film. Lens equipment offers choice of 8.5cm lenses from Exaktar $f/3.5$ to Tessar $f/2.8$ and Biotar $f/2$, 10cm or Primoplan $f/1.9$, 10cm. Interchangeable lenses available ranging from Wide Angle Tessar $f/6.3$, 6.5cm to Tele Tessar $f/6.3$, 18cm. Other lenses to be added later. Besides incorporating well known Exakta features, such as single lens, ground glass focusing, built-in flash synchronizer, unique shape and speed range from 12 seconds to 1/1000 of a second plus delayed action, the square format Exakta has automatic film transport of same order as incorporated in Kine Exakta; that is, one movement of lever winds film to next exposure, at same time winding shutter and dropping mirror into position.

DUROPOD ($3 to $6): Tripods characterized by light-weight, sturdiness, and long leg extension. Special reversible feature of legs permits head to be used for either American or German tripod bushings. Six different models available, ranging from three to eight sections. Finished in brass and stainless steel.

CAMERATROL ($19.95): New synchronizer for Photoflood bulbs, with remote control unit for photography by Photoflood light. With unit in place bulbs burn at ordinary brilliance of household lamps during preliminary focusing, composition, and placing. With shutter of camera set on bulb, operator presses remote control switch, which opens shutter and brings bulbs to full brilliance at same instant. Releasing remote control switch closes shutter and reduces power feeding bulbs at same time.

UNIVEX MERCURY 35MM CAMERA ($25): Equipped with $f/3.5$ lens and focal plane shutter with speeds from 1/20 to 1/1000 of a second. Also equipped with $f/2$ lens. All adjustments on front of camera. Equipped with built-in Photoflash synchronizer and automatic film transport synchronized with shutter winding knob. Exposure calculator and depth of field scale lie close to built-in parallax correcting view finder. Camera measures $5\frac{7}{16}$ by $2\frac{1}{2}$ by $1\frac{3}{8}$ inches, weighing 18 ounces. Seventeen focusing mount graduations allow approach as close to subject as one foot, six inches. Camera body of polished aluminum and genuine leather snap-closing casing. Film available in three types: Ultra Chrome for normally lighted action; Microtomic, fine grain panchromatic film; and Ultrapan, ultra-fast panchromatic film for use under adverse photographic conditions. Complete line of filters available made of fine ground optical glass, mounted in dead black brass mounts; also improved type of polarized filter.

KODASLIDE READY-MOUNT CHANGER ($12): Magazine-feed device for Kodaslide Projector Model 2 intended for use in showing groups of Kodachrome still transparencies or black-and-white film positives in new Ready-Mounts. Combination particularly useful for schools and illustrated lectures before small groups, as well as for home projection. Once supply magazine of Ready-Mount Changer is charged with group of slides, operator can show complete sequence without removing eyes from screen. Up to 50 Ready-Mount slides may be placed in supply magazine at one time. Slide-shifting mechanism operated by flexible 30-inch plunger resembling cable release but larger. Pressing in plunger moves slide into position; pulling it out readies it for following slide. Changer made of aluminum with small parts in bright metal.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

***Q.* Occasionally, in exhibition prints, I notice a fine lustre which appears to be a surface treatment. Can you tell me how this is done?—C. L.**

A. Mix equal parts of olive oil and turpentine and apply evenly over the surface with a wad of cotton, following this by polishing with a soft cloth. Another popular formula includes:

Benzol	8 ounces
Beeswax	1 ounce
Rosin	¼ ounce
Turpentine	2 ounces

Pour a little of the solution on the print and then rub in with cotton. When the entire print has been treated in this way, polish dry with a soft cloth or a fresh pad of dry cotton.

***Q.* Not being too familiar with the various makes of photographic lenses, I am at a loss in making a selection. I am contemplating the purchase of a twin-lens 2¼ by 2¼ reflex type camera. Which would be the more desirable, one equipped with a Rodenstock Trinar *f*/2.9 lens in Compur shutter, 1 second to 1/300th, or one having a Heliar *f*/3.5 lens in a Compur Rapid shutter, 1 second to 1/500th?—J. G. B.**

A. For all practical purposes, one lens will give as good a performance as the other. Your choice, therefore, must be on the basis of the other factors involved, the higher lens speed of the *f*/2.9 over the *f*/3.5, which is negligible, and the difference in the top shutter speeds. It would seem that the choice would depend chiefly on the design of the camera. Basically, they are the same, of course, but there are other factors which, in a personal estimate, would place one camera above the other.

***Q.* Can you cite me references to information on the hypersensitization of film by mercury vapor? Also on the subject of photography by infra-red light?—J. A. M.**

A. The method of dry hypersensitizing with mercury vapor is fully described by the discoverers, Dr. F. Dersch and Dr. H. Luerr, of the Agfa Ansco Research Laboratories, in the report of their experiments printed in the *Journal of the Society of Motion Picture Engineers* (Vol. XXVIII, No. 2). We believe that you may be able to obtain a reprint of this report by writing to the Agfa Ansco Company at Binghamton, New York. On the subject of infra-red photography, we can refer you to the chapter on this subject in the Eastman Kodak Company publication, "The Photography of Colored Objects"; to S. O. Rawlings' "Infra Red Photography"; and to Dr. Othmar Helwich's "Practical Infra Red Photography."

***Q.* At what aperture does my *f*/2.8 lens reach its maximum resolving power?—D. G. L.**

A. Generally, this occurs at the stop *f*/5.6; that is, two stops smaller than the maximum aperture of your lens. For this reason, if perfect sharpness is what you want, you would do best to try to work at this aperture whenever possible. Of course, stopping down will give you greater depth of field, in which case you will be willing to sacrifice the advantage of the maximum resolving power at *f*/5.6 for the sake of including more planes within the field of relatively sharp focus.

***Q.* Is there any means of achieving an *f*/64 aperture on my three-inch lens by means of a sort of Waterhouse stop?—A. L. W.**

A. The stop *f*/22 is the smallest that has been found practical with lenses of this short focal length, but the great depth of these miniature lenses as compared with those on the larger cameras more than makes up for this limitation as to diaphragm stops. The reason that extremely small stops, such as *f*/64, cannot be obtained with the miniature diaphragms is that the diffraction of light at these small openings would be too great and lack of sharpness would result. For an explanation of this, see page 255, April Scientific American. See also answer to D. G. L., above.

***Q.* My camera case has been used so long that it could stand a little reconditioning. What is a good polisher for this purpose?—D. K.**

A. Propert's Saddle Soap is a standby with many. An excellent formula that you can make up yourself and rub into the leather with a soft rag consists of 50 parts lanolin, 40 parts castor oil, and 5 parts each of sodium stearate and japan wax.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

TO *Nature* (London), in which scientists regularly report progress in their work for the information of other professional scientists, Dr. Walter S. Adams, Director of the Mt. Wilson Observatory, has given the account of work preliminary to final figuring of the 200″ mirror which follows.

"The present figure of the 200″ mirror approximates closely that of a sphere with a radius of curvature of 111 feet. The disk was first shaped on front, back, and edges by grinding with coarse Carborundum and the center was then hollowed out to a depth of about 3¾″ with the aid, first of a 50″ tool, and then of successively larger tools up to the full size of 200″. As the spherical figure was approached, finer grades of Carborundum were used, so that when optical tests became necessary only a few hours of polishing were needed to give the surface sufficient reflecting power. During the first stages of work upon the disk, the cylindrical holes on the back of the mirror and the large areas between the supporting ribs were filled with plaster of Paris, and after the face and back had been made parallel the 40″ opening at the center of the disk was closed with a glass plug weighing about one ton. The plaster of Paris was removed when the surface had reached nearly the required form, and the mirror was placed upon rubber pads which rest on the frame of the support system of multiple counterweighted levers. The friction of these pads was required to neutralize the strong lateral pull of the grinding and polishing tools making contact over so large a surface, and for this reason the horizontal plates of the supporting system were not engaged. The optical tests, however, were made with the mirror vertical and balanced upon the support system just as it will be when in use on the telescope. Future optical work, including the parabolizing, will be carried on with the mirror resting upon the rubber pads; but these will be removed when the figuring is completed.

"From the first the optical tests of the mirror proved to be most satisfactory. No change was seen in the figure when the mirror was tipped repeatedly from a horizontal to a vertical position or when it was rotated. Also no local deformations could be detected at the points of contact of the 36 individual lever supports. In fact, the support system was found to be performing quite as well as had been hoped by its designers. The length of the radius of curvature proved to be about 2″ less than had originally been planned, but this slight difference, amounting to about 1″ in the focal length, is far within the limits allowed for in the design of the telescope, and it is probable that no attempt will be made to reduce the amount through polishing. The surface was found to be reasonably free from zones, but a small amount of astigmatism was present amounting to about 0.1″ in the optical cut-off at the center of curvature. This proved to be due to a slight deformation of the disk caused by the horizontal pads upon which the mirror rests. [Supplementary note added in letter from Dr. Adams to Scientific American, to bring article up to a later date: "Through suitable changes in the supporting pads this astigmatism has now (March 15) been eliminated by a small amount of fine grinding and polishing. The zones have also been considerably reduced and the entire mirror surface is nearing an accurate spherical figure. Work will soon be commenced upon the final figuring of the 120″ plane mirror to be used in testing the parabolization of the 200″ surface."]

"Although the final parabolic curve of the surface of the mirror will be only 0.005″ deeper than the spherical curve, the area is so great and the process of polishing so slow that it is planned to make most of the change through fine grinding and to leave but the final stages of the figuring to the polishing tool. This procedure has already been found successful in figuring the spherical curve.

"Accurate tests of the parabolic figure of the 200″ mirror will require the use, as an auxiliary plane, of the 120″ mirror. The completion of this mirror will be one of the next major undertakings in the optical shop. It is at present shaped on front, back, and edges, and the surface has been ground approximately flat. It is planned to figure the three auxiliary hyperbolic mirrors, one for the Cassegrainian and two for the coudé combination, by the method devised by Hindle, without the use of the 200″ mirror. Four spherical mirrors, each about 40″ in diameter and with a radius of curvature of 25′, are being prepared for this purpose, two being very nearly completed. The mirrors will be used side by side in a cloverleaf pattern and provided with adjustments for bringing their centers of curvature into accurate coincidence.

"A few figures are of interest as indicating the scale of the optical work on the 200″ mirror. About five tons of glass have been removed in the process of shaping and figuring, and about 20 tons of Carborundum have been used for grinding. During the polishing, about 50 pounds of rouge an hour is the average consumption with the full-sized tool, and but a small fraction of this material can be salvaged. As a result, rouge has been purchased in quantities hitherto quite unfamiliar to dealers in optical supplies."

IF you can train your eyes to perform suitably, you can superpose the two images shown in Figure 1 and obtain a three-dimensional view of the 200″ mirror and of the lettered image. You are standing in the lofty visitor's gallery in the Optical Shop at the California Institute of Technology, in Pasadena, California, looking through the windows that divide the gallery from the room in which the big mirror ("lens," as newspaper writers still call it) is being completed. Axis of the mirror is about 2′ below your floor level. About 6′ below that, there is a kind of super-pinhole about a foot in diameter, with a lettered transparency over it and a powerful light-source behind it. The rays go to the mirror and are reflected back to a focus about 6′ above the axis, at your

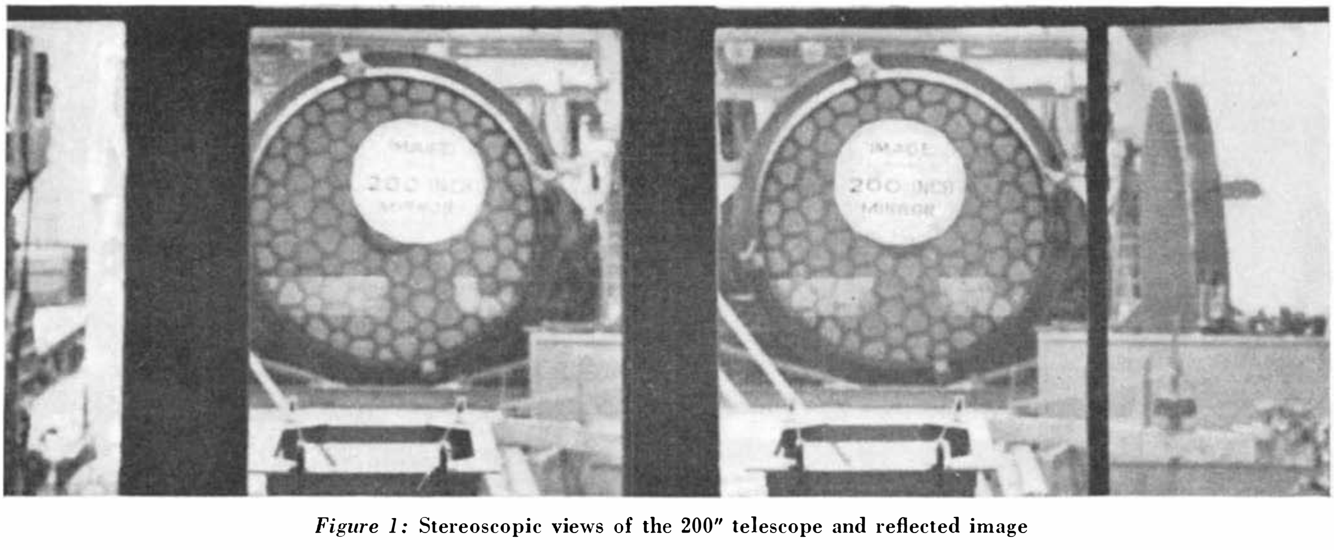


Figure 1: Stereoscopic views of the 200″ telescope and reflected image

approximate eye level and 2′ or so in front of the window. In Russell Porter's words, "you'd swear the image was material. Startling!" It seems to hang in space and you feel the urge to feel of it, others comment.

Thus far, however, there is nothing stereoscopic about it; in fact, the stereoscopic part has no connection with the apparatus or mirror but was obtained by taking two photographs from the visitor's gallery, the second one made with the camera shifted sidewise about the same distance as the separation of the average man's eyes. These photographs were taken by David O. Woodbury, an amateur telescope maker who, after spending several months in Pasadena and Mt. Palomar, has written a book about the 200″ telescope, one chapter of which was recently pre-published as an article in *Reader's Digest* (the entire book is due to appear in October).

There are three ways to get the three-dimensional effect: (1) use a mounted pair of prismatic lenses; (2) hold a long strip of cardboard between the end of your nose and the center of the pair of pictures, so that the right eye sees the right-hand picture alone and the left eye the left-hand picture alone, and then try to drift off into a focus on infinity (think dreamily about that brunette); or (3) command your eyes to do the trick without any cardboard—this can be done by many, after a bit of practice.

The square object in the immediate foreground is a rack to carry the knife-edge, when the mirror is tested à la Foucault.

RECENTLY, in one of the innumerable newspaper items which describe a mirror as a "lens," your scribe was further enlightened by the statement that a "lens" had been "polished with face powder!" It isn't difficult to figure out how this howler happened, but then followed this thought: "Could a passable polish be had with face rouge, and just what is in face rouge, anyway?" Will some face-rouge-experienced reader provide the answers?

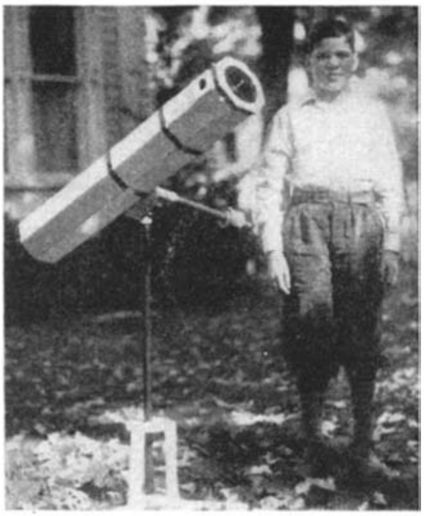
ANNOUNCEMENTS: Stellafane convention will be held on Saturday, July 22—R. J. Lyon, Secretary, Springfield Telescope Makers, 252 Summer St., Springfield, Vermont.

CARL GROSSWENDT, 31 W. 87th St., New York, Secretary of the Optical Division of the Amateur Astronomers Association, New York City, states that the Optical Division (which is simply the former New York Telescope Makers) cordially invites all amateurs who visit the New York World's Fair to inspect its workshop deep in the bowels of the earth under the Hayden Planetarium, at 81st St. and Central Park West. It asks that, if convenient, such visitors first notify the Optical Division by telephoning as follows: Mon., Tues., Wed., Thurs., Fri., 10 to 4, ENdicott 2-8500, Ext. 478; 6 to 9, Ext. 509. Sat. and Sun., 2 to 9, Ext. 509. Even if you lack opportunity to make such arrangement, the planetarium guard may by luck find someone in the optical workshop. Planetarium performances, which you may wish to combine with this visit, take place weekdays at 2:00, 3:30, 8:30. Saturdays at 11:00, 1:00, 2:00, 3:00, 4:00, 5:00, 8:30. Sundays and holidays at 2:00, 3:00, 4:00, 5:00, 8:30. An exhibition of products of amateur astronomers' activities will be held in an adjacent building from July 30 to Aug. 20,

THE BEGINNER'S CORNER

PROSPECTIVE beginners at telescope making very frequently have attacks of deep-dyed doubt regarding their ability to make a telescope, and to these we commend the two photographs reproduced here, showing telescopes made respectively by an 11-year-old lad and a lady. Not that telescope making is a juvenile or feminine hobby—in most cases it pretty definitely isn't. Simply, these telescope makers are beyond average in ability, for age and sex, but not men.

Donald Bird is the youth and Wallace C. Swank, science teacher at the Eaton Rapids Public Schools, Eaton Rapids, Mich., sends us an account of his success, stating that "Donald was 11 years old when he finished this telescope. Some of your readers may think," he continues, "that Donald did perhaps a little of the work and an older person most of it, but such is not the case; he did it all. His mirror is 4¼" in diameter with focal length 34", and is mounted in an octagonal tube of plywood. He used pipe fittings for the mounting." So far as the conductor of this department can recall, Donald Bird is the youngest lad to have made so creditable a telescope. Natural mechanic.



Donald Bird and his telescope

The lady in the other photograph is Mrs. Albert M. Bonelli, 2515 Drummond St., Vicksburg, Miss., and she states that "the greatest thrill I've had in years was reading in Scientific American that it wasn't impossible for me to do what others had done, and that I might realize a life's ambition by making and owning a telescope. So I obtained a kit of materials, your instruction book 'Amateur Telescope Making,' and got busy. This 6" reflector was the outcome, after 72 total hours of hard work."

Mrs. Bonelli and her reflector

In difficulty the amateur telescoptical hobby starts at the level of work such as these examples and may be made to extend just as far as the follower cares to extend it toward and into really advanced work.

FROM a very old hand at the telescope making hobby, Harold A. Lower, of San Diego, we receive the following comment: "Here is something I think you ought to bear down on, in your Beginner's Corner—the chapter in 'Amateur Telescope Making' on zonal testing. I have found that there are a surprising number of amateurs, some of whom have made several mirrors, who don't even know that chapter is in the book. Lots of them think all they need to do is use a Ronchi grating, and polish until they get curved lines. Naturally, the result is usually a deep hyperbola. Honestly, I think there would be more good mirrors if the Ronchi test had never been heard of. It is useful, of course, but most beginners depend on it too much."

The chapter on zonal testing extends from page 96 to page 100 of "ATM".

TELESCOPTICS

(Continued from preceding page)

inclusive, and a convention of amateur astronomers will be held on August 19 and 20.

In "Amateur Telescope Making—Advanced," the sequel book to "Amateur Telescope Making," H. E. Dall describes the camera obscura, which is essentially a refracting telescope for use from indoors. The first since then to make one is William R. Crosby, 566 Glide St., Rochester, N. Y., a member of the thriving group of amateurs in that city. Figures 2, 3 and 4 show the design and construction. At the top, in Figure 2, is an elevation showing a roof and, projecting above it, a flat both pivoted and rotatable. This picks up rays from any chosen object and directs them downward through the objective lens shown, which projects an image on a horizontal viewing table several feet beneath. Here the image may be viewed with the eye or, if still higher magnification is desired, with a microscope called a viewing telescope. The lower elevation shows the apparatus from another quarter.

Crosby, however, did not build his camera obscura into his house but into his automobile trailer. Figure 2, taken outside, shows the trailer roof and the raised flat, while Fig-

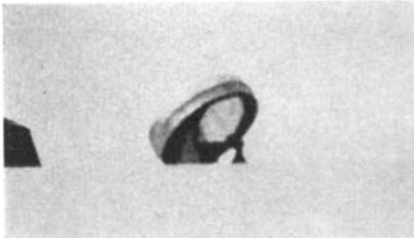


Figure 2: Roof, flat, and its hat

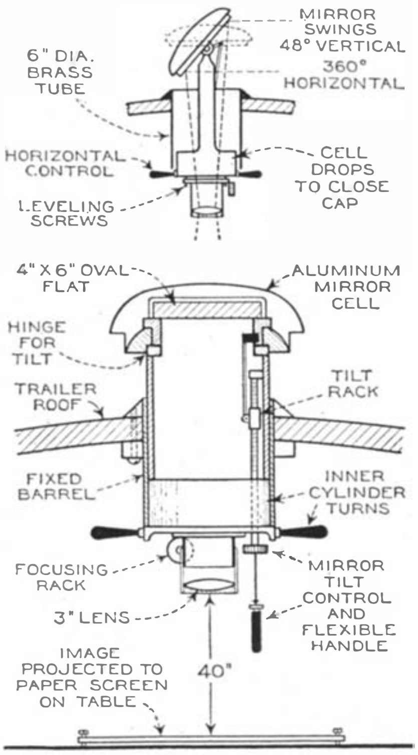


Figure 3: Front and side views

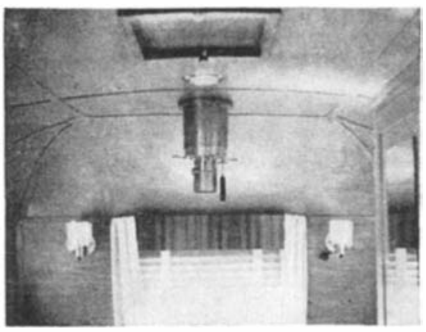


Figure 4: The inside end of it

ure 4 shows the interior part of the instrument, also the interior of the trailer (this Crosby also built).

Your scribe has sat in this trailer, rotated the flat and examined the landscape roundabout, and can testify that the spectacle came far above best expectations. Because the observer sits in the dark, his eye is not sky-flooded. Therefore the large image on the table appears to be vividly colored—even more vividly than the actual landscape. A long, continuous panorama of greens and sky-blues sweeps across the viewing table, which in this case is the dining table of the trailer, and several persons can examine it at one time. For astronomical work the camera obscura equates with a refractor of the enclosed observing room type.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

15 Years Behind the Brush is a 30-page pamphlet which deals specifically with the use of aluminum paint for wood priming. A number of excellent photographs show the results obtained with this protective coating both from the standpoint of preservation of the wood as well as of the durability of the paint which is applied over the primer. *Aluminum Company of America, Pittsburgh, Pennsylvania.—Gratis.*

Half a Million Men is a 16-page booklet designed to picture what manner of man is the steel worker, not only from the economic side but from the human and social side as well. The illustrations combined with pictorial graphs give an excellent insight into this large group of American industrial employees. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York.—Gratis.*

Speed Flash Booklet is an illustrated 36-page manual on Speed Flash Photography. It includes examples of prize winning pictures; complete exposure charts for distance and various size flashbulbs, including both foil and wire types; and exposure recommendations for all films. Drawings provide hints on how the Speed Flash owner may make adjustments for various conditions and different types of bulbs. *The Kalart Company, 915 Broadway, New York, New York.—Gratis.*

Private Interest and Public Responsibility, by Edward L. Bernays, reflects the attitude of a counsel on public relations toward our present system of conducting industry and business. He deals with such things as the basis of democracy; the free competitive system; the importance of progress through change; scientific inquiry; the need of business for objectivity; and self-regulation of industry. *Edward L. Bernays, 420 Lexington Avenue, New York, New York.—Gratis.*

Cheney Flashing is a 16-page booklet explaining the principle of cutting off seepage and leaks through masonry walls exposed to rain by means of copper flashing extending through the wall as a positive cut-off. *Revere Copper and Brass, Inc., 230 Park Ave., New York, New York.—Gratis.*

Enlarging, the Real Fun of Photography is an eight-page booklet that gives the fundamentals of projection printing for the amateur. It contains a series of excellent photographs that illustrate various steps discussed in the text. *Federal Stamping & Engineering Corp., 25 Lafayette Street, Brooklyn, New York.—Gratis.*

Allied's Radio Builder's Handbook is a 30-page booklet prepared to assist radio beginners to get started in building radio receiving sets. The essential fundamentals are explained in detail and many circuits are given, together with data for simplified construction. Illustrated throughout with clear and comprehensive drawings and a few photographs. *Allied Radio Corporation, 833 West Jackson Blvd., Chicago, Illinois.—10 cents.*

Repair Clamps and Saddles for Steel and Cast Iron Pipe, Catalog No. 38A, is of particular interest to those who are concerned with the maintenance of pipe lines of any type. These repair devices are available for use on lines carrying steam, hot or cold water, gas, oil, ammonia, or brine. A number of types adapted to various applications are illustrated and enough information is given to show their particular uses. *M. B. Skinner Company, South Bend, Indiana.—Gratis.*

Electricity and Wheels, by Ralph A. Richardson, is a 32-page, fully illustrated booklet that tells in an interesting manner of electrical progress from the discovery of the magnet down to the present day. It reviews in particular the part played by electricity and electrical devices in the modern motor car. *General Motors Corporation, Broadway at 57th Street, New York, New York.—Gratis.*

Mica Transmitting Capacitors of a new highly efficient design are completely described in a pamphlet now available. The design of these capacitors is such as safely to eliminate corona and to reduce internal heating. Dielectric loss in these units is remarkably low, permitting long periods of heavy-duty operation. Catalogue No. 161. *Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.—Gratis.*

Get the Inside Story is an attractive and interestingly written booklet that describes one particular type of household refrigerator and shows the many advantages which are claimed for it by its manufacturer. The pamphlet also goes into some detail regarding the construction and testing of these refrigerators before they reach the ultimate consumer. Technicalities are dealt with, but in simple, understandable language. *General Electric Company, Nela Park, Cleveland, Ohio.—Gratis.*

Jackson Eyeshields is a folded circular which illustrates and describes various types of eyeshields which have been designed specifically for the protection of industrial workers. *Jackson Electrode Holder Co., 15122 Mack Avenue, Detroit, Michigan.—Gratis.*

The Picture Story of Steel is a 48-page lavishly illustrated booklet that tells the whole story of its subject from the mining of the ore through smelting, fabrication, and testing, to the finished steel and its uses in the home, in transportation, in construction, and in industry. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York.—Gratis.*

Victor Photographic Specialities is a 16-page catalogue that deals with a wide range of lighting equipment for the amateur photographer as well as the professional. *James H. Smith & Sons Corp., Lake and Colfax Streets, Griffith, Indiana.—Gratis.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

Fair News

THE New York World's Fair Corporation has recently restrained a publisher from using the title "Illustrated Fair News" in connection with a magazine relating to the New York World's Fair. The publisher originally published a magazine entitled "World's Fair News" and the New York World's Fair Corporation obtained an injunction restraining him from publishing a magazine under that name. Shortly after the original injunction was issued, the defendant indicated his intention of using the name "Illustrated Fair News" in connection with the magazine and the New York World's Fair Corporation made an application to have its injunction extended so as to restrain the new name. The Court extended the injunction and restrained the use of the new name on the grounds that the publication "was obviously designed for the purpose of enabling them to continue their exploitation for business purposes of the possibilities arising out of the World's Fair."

Experimentation

A PATENT for a process must fully describe the process so that it can be carried out by the proverbial "man skilled in the art" without the necessity of any further experimentation. If further experimentation is necessary to carry out the process, the patent is invalid for the reason that it is indefinite and does not fully disclose the invention.

This principle is exemplified by a recent suit for patent infringement which involved a patent for a process for propagating yeast in which the production of alcohol is reduced to a minimum. In describing the process the patent suggests that seed yeast be placed in a wort having a specific gravity of one degree Balling. After the process of reproduction is initiated, concentrated wort having a specific gravity of approximately 12 degrees Balling is slowly and substantially continuously added to the original wort over a protracted period of time. The patent states that the concentrated wort should be added "at a rate such that not only the alcohol which may have been formed from the quantity of sugar present in the diluted portion of the wort, but also any alcohol which may be formed from the sugar which is present in the added wort, can be assimilated immediately by the yeast."

The Court held that further experimentation was necessary in order to ascertain the times and manner in which the concentrated wort should be added. For this reason the Court held that the patent was indefinite, did not fully disclose the invention, and accordingly was invalid. In reaching this conclusion the Court made the following statement:

"But even if the process disclosed by Hayduck be held to constitute invention, the patent is invalid for indefiniteness as was held by the learned District Judge. Both the times and manner in which the concentrated nutrient solution is to be added may be ascertained, as we have stated, solely by experimentation. The disclosure of the patent is therefore too vague and indefinite to constitute invention."

Doubt

IT is an established principle of patent law that in connection with the prosecution of patent applications all doubts with regard to the question of invention must be resolved in favor of the applicant. Thus in a case where doubt existed as to whether the advance made by the applicant for a patent rose to the dignity of invention or merely amounted to mechanical skill, the doubt should be resolved in favor of the applicant and accordingly a patent should be granted.

In a recent case involving an application for a patent on a method of making artificial sausage casings the Examiner had originally held that two of the claims were patentable. Thereafter the Examiner reversed his decision and held that the claims in question were not patentable. On appeal to the Court of Customs and Patent Appeals it was contended by the applicant that the Examiner's action in originally allowing the claims, and then rejecting them, indicated that there was some doubt on the question of invention. It was argued that in accordance with the principle set forth above the doubt should be resolved in favor of the applicant and the claims should be allowed. The Court of Customs and Patent Appeals rejected this contention and held that the mere fact that the Examiner had reversed himself did not indicate that there was doubt on the question of invention.

Breathing

THE word "breathing" as applied to textile fabrics was held to be descriptive by the Court of Customs and Patent Appeals and accordingly not registerable under the Federal Trade Mark Act of 1905.

A textile manufacturer attempted to register the words "Breathing Back" as a trade mark for pile fabrics having an adhesive coating on the back thereof which was impervious to water but pervious to gases and air. The registration of the mark was opposed by a competitor of the manufacturer on the grounds that the words "Breathing Back" were merely descriptive of the characteristics of the pile fabric. The Court found that the word "breathing" had been used for many years to describe artificial leather and certain fabrics which were pervious to gases and air. It was accordingly concluded by the Court that the words "Breathing Back" were merely descriptive of the pervious characteristic of the pile fabric and under the circumstances the words could not be registered as a trade mark. In rendering its opinion the Court stated as follows:

"We are of the opinion that 'Breathing Back' as applied to applicant's goods does nothing more than to describe the character of the back of applicant's pile fabric which, by reason of its porosity, permits breathing or passage of the air through the back."

Antenna

IN a recent case of importance to the radio communications industry the United States Supreme Court held that a patent on a directional antenna was not infringed by antennas employed by one of the large radio communications companies.

The Court found that the patent in suit related to a V-shaped wire antenna based on the so-called "Abraham formula," which provides that when radio activity is projected from a charged wire having a length which is a multiple of one half the length of the waves projected by the antenna, the angle of the principal radio activity is a function of two variables, namely, the wavelength and the number of half wavelengths contained in the wire. The patent in suit set forth an empirical formula based on the "Abraham formula" for determining the most efficient angle for disposing the wires in a V-shaped directional radio antenna. The Court found that the patent, being based on the "Abraham formula," was strictly limited to an antenna in which the length of the wire was a multiple of one-half wavelengths. All of the antennas employed by the defendant, with the exception of one, were found to have a length which was a multiple of one-quarter wavelengths but not of one-half wavelengths. These antennas were held not to come within the "Abraham formula" and not to infringe the patent.

The remaining antenna which had a length which was a multiple of one-half wavelengths was found to be disposed at an angle smaller than that prescribed by the formula set forth in the patent in suit and it was held not to be an infringement.

Spaghetti

MANY spaghetti eaters will no doubt be annoyed by allegations of the Federal Trade Commission that the authenticity of spaghetti is not determined by the length thereof. In a recent proceedings instituted by the Federal Trade Commission against a manufacturer of spaghetti and macaroni it was charged that the manufacturer was guilty of unfair methods of competition because his advertising matter stated that macaroni and spaghetti not made in long lengths was not genuine. The Commission charged that these statements were false, deceptive, and misleading and the manufacturer was ordered to show cause why he should not cease and desist from making further representations of this character.

INDEX TO VOLUME 160, JANUARY-JUNE, 1939

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For MEN

who want to become independent

in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

He will lean back in his chair with the easy confidence and poise that are the hall-mark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent *sometime;* the other class have convinced themselves that they can do it within the next few years. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a booklet that has put 400,000 men on the road to more rapid progress?

This booklet costs you nothing—and for a good reason. It is worth only what you make it worth. It explains how for more than thirty years it has been the privilege of the Alexander Hamilton Institute to help men shorten the path to success; to increase their earning power; to make them masters of the larger opportunities in business.

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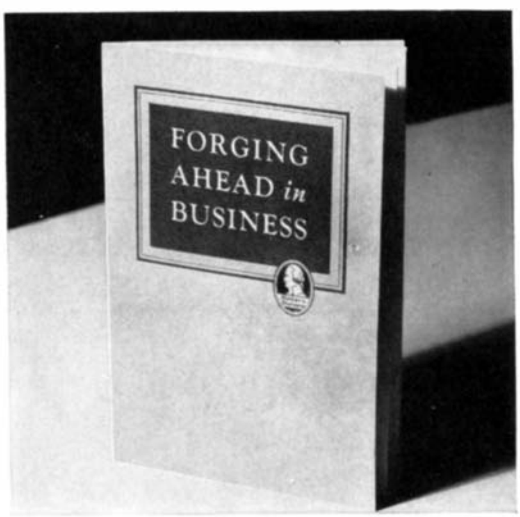

"FORGING AHEAD IN BUSINESS" is an interesting, helpful booklet. It is yours for the asking. Send for it. Measure yourself by it. Look clearly, for a few moments, into *your* next few years. Whether or not you will follow the path it points is a matter that you alone must decide.

•

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